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FEBRUARY/MARCH 1995

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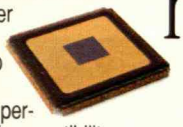

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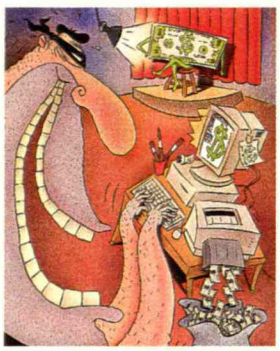
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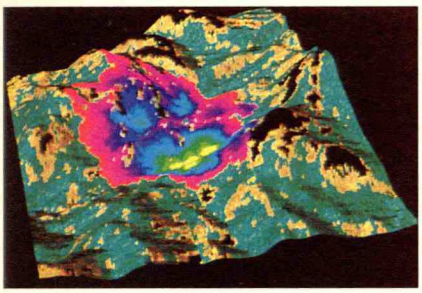

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Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October, and November/December) by the Association of Alumni and Alumnae of the Massachusetts Institute of Technology. The editors seek diverse views, and authors' opinions do not represent the official policies of their institutions or those of MIT. We welcome letters to the editor. Please address them to Letters Editor, c/o address below or by e-mail to: <technology-review-letters@mit.edu>.

Editorial, circulation, and advertising offices: *Technology Review*, Building W59, MIT, Cambridge, MA 02139, (617) 253-8250; FAX (617) 258-7264. Printed by Lane Press, S. Burlington, VT. Second-class postage paid at Boston, MA and additional mailing offices. Postmaster: send address changes to *Technology Review*, MIT, Building W59, Cambridge, MA 02139, or e-mail to <traddress@mit.edu>.

Subscriptions: $30 per year. Canada add $6, other foreign countries add $12. Contact *Technology Review*, P.O. Box 489, Mount Morris, IL 61054, (800) 877-5230 or (815) 734-1116; FAX (815) 734-1127, or e-mail to <trsubscriptions@mit.edu>.

Advertising representatives: Mark E. Lynch, Eastern Sales Manager, 9 Salem Drive, Saratoga Springs, NY 12866, (518) 583-6086; William R. Cook, National Accounts Manager, P.O. Box 973, Duxbury, MA 02331, (617) 934-9714; The Leadership Network: Kiki Paris, 200 Madison Ave., New York, NY 10016, (212) 686-1734; Albaum, Maiorana & Associates, 418 W. 5th St., Royal Oak, MI 48067, (313) 546-2222. *Technology Review*'s e-mail address: <tradvertising@mit.edu>.

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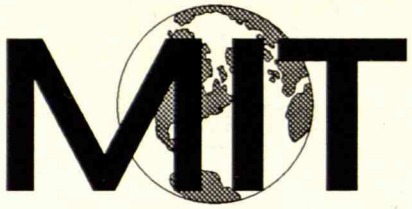

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Powerful Partners

THE early 1980s were a pivotal time for the major players of the U.S. steel industry. Threatened by competition from overseas producers who had invested in innovative technology for making steel more cheaply, as well as from minimills recycling scrap steel at home, steelmakers had to retool on a massive scale. Giant firms such as U.S. Steel not only slashed their capacity by a quarter and their workforces by more than half but also faced the need to reorganize remaining employees to produce high-quality, high-value-added goods.

Conventional wisdom may have had it that the most compliant locals of the United Steelworkers of America would fare better under these circumstances than their brothers and sisters who were seemingly more confrontational. Yet according to a comparison of two steelmaking plants by Richard M. Locke and Ann C. Frost of MIT's Sloan School of Management, the local with a history of standing up to, as well as working with, both plant management and the national union has been highly successful in hammering out the complexities of workplace restructuring.

At Inland Steel's Indiana Harbor Works in East Chicago, Ind., Local 1010 participates in a steering committee that draws on the input of both rank-and-file workers and managers to determine the content of new jobs. In this capacity, the local can both cancel the game and play ball: although 1010 withdrew its support from a purported total quality management program that simply pursued layoffs, effectively ending the effort, the overall number of unionized employees as well as supervisory staff has been cut.

At Gary Works, the flagship facility for U.S. Steel that produces some 60 percent of its output, in contrast, management has begun an "employee-involvement program" over which it has sole control, and has combined formerly distinct jobs without consulting local 1066.

Locke and Frost say Indiana's 1010 is able to work as a cooperative but uncoopted partner because it has long posted elected representatives throughout the plant who must respond to the demands of employees as well as resolve disputes with management. Locke and Frost see the seeds of a reborn labor movement in locals that take back negotiations formerly assumed by the national union.

According to the Dunlop commission, which recently reported its findings on the future of U.S. labor-management relations, the kind of energetic representation 1010 provides is urgently needed as American workplaces not only attempt to tap employees' know-how to improve productivity but wrestle with expanding federal mandates on disability, safety and health, and education and training. The commission finds that employees want more say over the conditions under which they work, while managers want more flexibility in conforming to regulations. The commission encourages workplaces to experiment with innovative forms of self-governance that give employees an active role in resolving disputes and establishing policies.

It's better to play together than to prey together.

In "Bringing New Materials to Market" in this issue, Thomas W. Eagar (a professor of materials engineering at MIT) sees the need for similar cooperation between complementary companies that have too often taken each other for granted. In an industry that suffers from a 20-year delay between invention and widespread use of a novel substance, collaborative ventures between suppliers of new materials and potential users such as automakers—in which, for example, they might share proprietary information and perform joint research—will give both parties the security to invest in new products and processes. As columnist Bennett Harrison pointed out in "Global Winners and Losers" *(TR July 1990)*, cooperation between strong complementary partners is not a common strategy in American business: auto companies often play off suppliers against each other while demanding quality that those companies are ill-equipped to deliver without a long-term commitment.

Far from dismissing the federal government as irrelevant to local concerns, the Dunlop commission sees a role for national agencies in analyzing which innovations in labor-management relations are most effective and ensuring that workplace committees meet strong standards for fair representation. Eagar, too, views the government as a key figure in facilitating cooperation among diverse parties, as it has done by organizing and partially funding the Sematech consortium to improve the manufacture of semiconductors. Meanwhile, Locke and Frost envision a corresponding role for national unions as information clearinghouses rather than as central directors of top-down strategies.

Yet global forces threaten to swamp even the national economy, as evidenced by recent debate over the nascent World Trade Organization. Maintaining living wages and tough environmental standards in the face of international competition will require action from that very institution, Jonathan Schlefer points out in his review of *America: Who Really Pays the Taxes?*, also in this issue.

The prospect of ensuring that the WTO will fulfill such a role is daunting. But as the steelworkers' experience shows, the knowledge and drive required to create effective institutions spring from cooperation for mutual gain among powerful players. Rather than reacting to deep uncertainty about their economic future by electing representatives intent on the wholesale dismantling of agencies and programs, voters energized through participation in workplace governance might instead choose leaders resolved to strengthen established institutions and set up new ones.■

—SANDRA HACKMAN

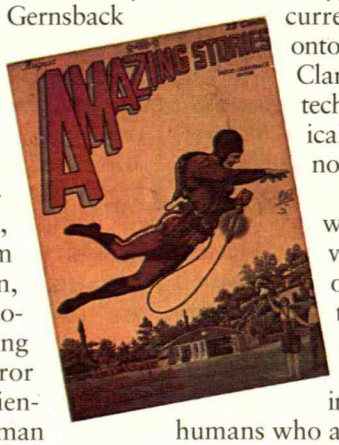
Letters

LITERARY FALLOUT

In Frederik Pohl's "Science Fiction: Stepchild of Science" (*TR October 1994*), it was good to be reminded that for many readers outside English departments, it's the (speculative) science in science fiction that has made it stimulating and fun, not just the style. As I was myself stimulated to pursue a career in science by the "juvenile" novels of Robert A. Heinlein, Poul Anderson, and, yes, Frederick Pohl, I was heartened to read his account of science fiction's role in inspiring so many great scientists. One can only hope that it still has such power.

DAVID MEAD
Science Fiction Research Association
Texas A&M University
Corpus Christi, Tex.

Frederik Pohl summarizes well the history of science fiction as I've lived it, since Hugo Gernsback, editor of *Amazing Stories*, printed my first short story in 1928. Early editors like Gernsback and John W. Campbell were optimists, dreaming of new technologies that could build a better world and take us to the stars. Those dreams were shattered by the atomic bomb, which left a mushroom cloud over science fiction, raising a flood of post-holocaust stories and inspiring numerous grade "B" horror films about misguided scientists seeking knowledge "man was not meant to know." I wonder if these dark visions feed the distrust of science and technology prevailing today.



JACK WILLIAMSON
Portales, N.M.

Frederik Pohl's notions about the predictive and educational value of science fiction apply well to the work of Verne and Wells. However, three problems degrade the value of today's science fiction, all of which apply especially to the assorted *Star Trek* programs and films.

The first *Star Trek* pilot program centered around telepathy, the second around ESP. These themes set the tone for many stories in which plausible futuristic science (space flight, high-power computers, beam weapons, genetic engineering) combines with genetically compatible humans and aliens, who exhibit various exotic mental powers. This mix of pseudo and real science confuses people, legitimizes fantasies, and contributes to the high level of superstition running through our postmodern society.

The second problem is science fiction's general failure to accurately project the accelerating pace of change. Much of the seemingly distant technology of the original *Star Trek* series is already in use, including portable communicators, remote medical imaging, and voice-activated computers. More recent *Star Trek* programs portray people centuries from now clicking away at computers not much different from the one this was typed upon, projecting the current pace of technology onto the future. As Arthur C. Clarke has explained, future technology will appear magical to the point that it will not be recognizable.

The third and perhaps worst problem is what I view as the mishandling of the human-robot question. Almost all future fiction has humans competing with robots indefinitely. (Pohl writes about humans who are scanned and beamed to a distant star, which begs the question of why a transferable mind would want to remain stuck with the form of a derived ape.) If robots become conscious in a manner analogous to humans, there will be no robot-human interaction or competition. The former will swiftly boost mental and physical powers to levels far beyond mere mortals. Human minds will have two choices—go fishing or go robotic.

Science fiction is in a quandary that has forced it into stagnation. People want to write and read about people.

Even works portraying the coming cyberspace are anthropocentric. And we humans want to feel superior or at least equal to everything else, so robots (and aliens) are portrayed as flawed. But the future is not likely to be anthropocentric. The result is a genre that has become more escapist than predictive.

GREGORY S. PAUL
Baltimore, Md.

FIERY DEFINITIONS

In "The Coolest Sound" (*TR October 1994*) by Simson Garfinkel, I read that chlorofluorocarbons "have been used in [refrigeration] because they're cheap, nontoxic, and inflammable." I doubt very much that these products would be so common if they ignited readily. The addition of "in" to "flammable" doesn't change the meaning to "not flammable." Some decades back, in recognition of this general misunderstanding, a few new usages came into play: nonflammable is now used for noninflammable and flammable for inflammable.

REYNOLD GREENSTONE
Brookeville, Md.

TRACKING STUDENTS

In "Off the Track" (*TR October 1994*), it's unfortunate that Ellen Ruppel Shell does not use a cause-and-effect analysis in her criticism of tracking in schools. For example, she speculates that lack of tracking is the reason why Japanese and European students perform well in school, but perhaps a longer school year and time-on-task are also important factors. In any case, let's avoid vague statements such as that students "were probably not tracked at all" (with what probability?) or "the very lack of tracking has, arguably, helped" (where is the concrete information?). Perhaps Shell would board an airplane or drive across a bridge designed by students who weren't tracked. I'll stick with those who were designated as members of the top 2 to 3 percent of the class.

CLARENCE J. MADAY
Raleigh, N.C.

Ellen Ruppel Shell makes excellent points regarding the effects of teacher competency, expectations, and philosophy on low-track classes but fails to draw the clear conclusion that these are teacher problems, not tracking problems. Further, while she cites the theoretical advantage of mixed classes to high achievers, she ignores the well-documented ostracism of high achievers in heterogeneous classes. Parents of gifted children know all too well that these students often intentionally underachieve to avoid denigration and verbal abuse by their classmates. Ability grouping creates a sanctuary where it is acceptable to excel and where, indeed, peer pressure encourages it.

Ability grouping is not an educational panacea and does unquestionably have disadvantages, particularly if the grouping system is rigid and inflexible. However, the approach at least makes some attempt to address the individual needs of students. In the real world, "administrators who manage to eliminate tracking in their schools" too often offer nothing to replace it, unreasonably expecting teachers in oversized classes to somehow meet the diverse needs of their students. Even the most dedicated and competent teacher is doomed to failure.

FRANK J. VENUTI
Big Flats, N.Y.

As a German/American family, we have directly experienced a European educational system, and we disagree with Ellen Ruppel Shell. The German school system more rigidly "tracks" younger and older students by nominal ability than is the case in U.S. public schools. In all the older German states, students are segregated by academic level immediately after the fourth or fifth elementary grade. Students then attend separate schools, *Gymnasium* for the university-bound and *Realschule* for more general-ability students. Special education students, rarely mainstreamed, are sent to their own schools.

The only difference we have found is that German schools place more emphasis on oral presentation and less on rote learning. The German system does have one advantage in that schools there don't have to deal with the children of a disadvantaged social underclass to the extent that many American inner-city schools must.

JEAN RENARD WARD
MARIA RUETERS
Arlington, Mass.

STATISTICS MISUSED

In "How Numbers Can Trick You" (*TR October 1994*), Arnold Barnett omits or downplays some important points about the misuse of statistics. First, most important public policy issues are posed or judged in statistical terms. But the statistical underpinnings of the "evidence" used to debate such issues are often weak, decision makers are ill prepared to use or evaluate the "data," and apparently convincing statistical arguments are available on both sides. Examples include whether IQ is inherited or can be altered, whether fish stocks have been permanently ruined in Prince William Sound, and whether Agent Orange or breast implants actually cause disease, and so on. Second, much recent scientific fraud has been cloaked in statistical maneuvering or has featured altered data that create an impression of statistical significance. And third, even honest researchers make inexcusable errors that render their statistics useless. After the EPA disclosed that residents of Love Canal had suffered chromosome damage, it was discovered that we all have similar amounts of damage—a finding that the simple use of a control group would have prevented. If supposedly competent practitioners can disagree with one another and make such errors, how can we blame newspapers and television for misinterpreting statistics?

DANIEL E. WHITNEY
Arlington, Mass.

When we compare statistics on the safety of various forms of travel, I think "passenger-hours" should replace "passenger-miles." On a 600-mile trip, car passengers are at risk for ten hours while airplane passengers are at risk for about one. A 600-mile automobile trip ought to be compared instead with a 6,000-mile airplane trip.

SIDNEY FREIDIN
Laredo, Tex.

Arnold Barnett responds:
The Love Canal case Daniel E. Whitney mentions actually falls within the purview of my article since it involves an "unsound comparison" (statistical sin #5) with the wrong baseline. I did also mention that researchers as well as journalists contribute to statistical lapses in the media. Regarding Sidney Freidin's point: Are we really safer traveling from A to B if the risk per hour drops 50 percent but the trip time grows by a factor of 10?

In the January issue, letter writer Ted Tsomides alleged that I myself chose an extreme case in illustrating how confusion between "likelihood" and "odds" led to exaggerated perceptions of racial bias in Georgia death sentencing. I assumed that the risk that a perpetrator would receive the death penalty if the victim was white was 99 percent. My selection of that number did have a plausible basis. Georgia white-victim murder cases divide into those in which virtually no one is executed (such as barroom brawls) and those that routinely evoke death sentences (such as kidnap-murders). Racial differences in overall death-sentencing rates must therefore, almost by definition, arise from the second group. Thus my choice of a 99 percent death risk was not unreasonable for the situation under discussion.

TORPEDO DISTINCTIONS

The "specialized form of autonomous vehicle" that J. Robert Fricke refers to as Civil War vintage in "Down to the Sea in Robots" (*TR October 1994*) was not born until the 1880s. The torpedo of that war actually took two more basic forms: those that Admiral Farragut damned at the Battle of Mobile Bay, which were actually moored mines, and spar torpedoes, which were attached to the tip of a long pole extending from the bow of a fast power launch. Under cover of darkness, the crew would aim it at a target vessel, strap down the throttle, and often abandon ship, leaving it to ram its torpedo-tipped spar into the enemy. It was the latter type that had modest success in the Civil War.

ROBERT W. PERKINS
Easton, Md.

SCIENCE AND THE PEOPLE

In "Updating the Social Contract for Science" *(TR November/December 1994)*, David H. Guston and Kenneth Keniston portrayed the strains felt by scientists and engineers, and they accurately conveyed many of the frustrations politicians and ordinary citizens feel concerning science and technology. I was especially pleased that the authors referred to a proposal by the Carnegie Commission to establish a National Forum on Science and Technology Goals. The 21st Century Project recently received a $50,000 grant from the National Science Foundation to help develop such a forum to allow citizens to participate in this critical aspect of policymaking.

The article's only shortcoming was its failure to address the subject of national goals more directly. For the public to be persuaded, once again, that science and technology funded with public money can be national assets deserving nearly a hundred billion dollars a year, we need clearly stated goals tied to national needs, and both the goals and the needs should be determined and assessed through democratic debate. We also need goals that are more specific, more measurable, and more relevant to the public mission of government than vague nostrums about "economic competitiveness" or "world leadership in science and technology."

If our goals are vague, pork barrel interests will fill the vacuum. The hard task ahead is to build a political constituency that will fight for the public interest. Scientists and engineers are typically neophytes in this kind of effort. They need alliances with citizens who understand what's at stake, and all of us need new institutions to give the public interest a fighting chance.

GARY CHAPMAN
Coordinator
The 21st Century Project
University of Texas
Austin, Tex.

Guston and Keniston remarked on the lessened need to apply science to defense. But the military threat was not eliminated by the dissolution of the former Soviet empire. History reminds us that military threats have arisen from unexpected sources in relatively short periods of time. Who in 1917 expected Germany and Japan to be serious military threats within 20 years? Similarly, who in 1939 expected the Soviet Union to be so militarily strong within a decade? Any number of countries could threaten us in a few years. We live in a dangerous world and science is no less important now to military preparedness than it was five years ago. As the Roman statesman, Cato, said over 2,000 years ago, "If you would have peace, be prepared for war."

W. VAN SNYDER
La Crescenta, Calif.

CORRECTION:
In "Tapping the Fire Down Below" (*TR January 1995*), by David Tenenbaum, we misidentified the secretary of energy as Helen O'Leary. Ms. O'Leary's first name is Hazel. We regret the error.—*ed.*

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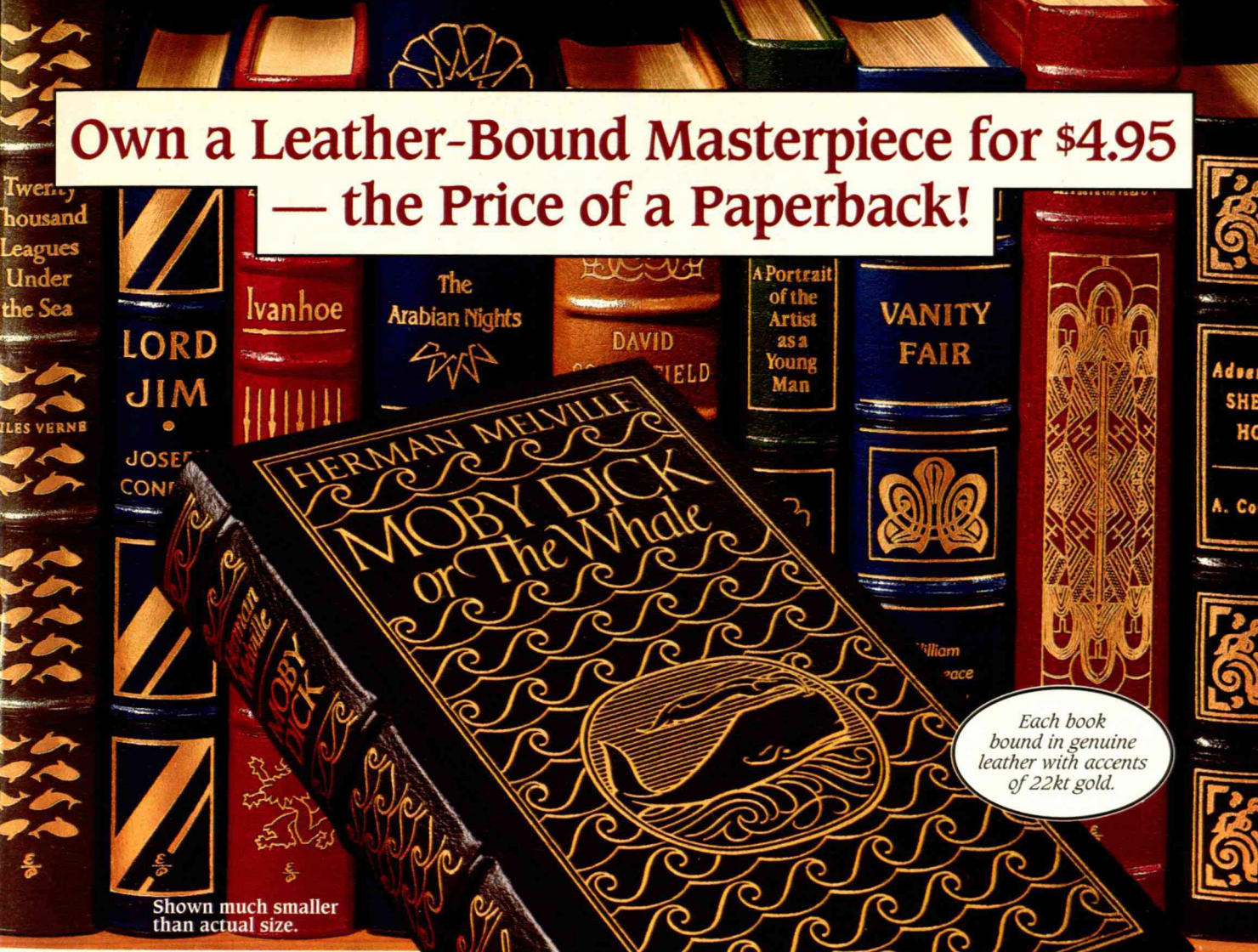

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MIT Reporter

Virtual reality unfolds more smoothly when the tracking device in Eric Foxlin's hands is worn atop the headset at left. The secret is in the unit's tiny gyros, which sense changes in the angle of one's head without the distortion that plagues other trackers.

Knowing Where Your Head Is At

You can immerse yourself in a state-of-the-art virtual-reality system, but no matter how gripping the illusion of flying an F-14 or touring a skyscraper, it is hard to escape the sensation that you are eight years old again and trying to read a comic book in the back seat of a moving vehicle.

The late-twentieth-century form of nausea known as simulator sickness arises from the jittery, swimming images that appear on most of the head-mounted displays used in virtual reality, and it is one of several virtual hang-ups that Eric Foxlin hopes to remedy. The problem is the tracker, the device that tells the computer where the user's head is and which way it is pointing. "Computers have gotten faster and head-mounted displays have seen quite a bit of progress," says Foxlin, "but we've been using essentially the same tracker—a magnetic system—for the last 10 years." Foxlin, a graduate student in the Sensory Communications Group at MIT's Research Laboratory of Electronics, has high hopes for a tracker based on inertial navigation.

Magnetic trackers sense the orientation of the user's head by measuring the distance between three emitter coils on the ceiling and three receiver coils on the headset. This process takes time—roughly 20 milliseconds for sampling the strengths of the signals, filtering out electromagnetic "noise" from metal objects or electronic equipment in the same room, and performing calculations, says Foxlin. So when you turn your head, the virtual landscape you are viewing lags perceptibly. Add to this the shuddering of an image because of noise that eludes the filters, and it's time for a Dramamine.

No less serious a drawback is the lack of range. The radius of magnetic tracking systems is usually restricted to a few feet, says Foxlin—both because of health concerns over the effects of strong magnetic fields and because it would be impractical to clear a larger space of metal objects.

Although a few tracking systems use other technologies that avoid some of these shortcomings, Foxlin notes major flaws in each alternative. Acoustic systems, for example, replace magnetic devices with ultrasound emitters and receivers, protecting against interference from filing cabinets but not from echoes, jangling keys, or moving air. They are also constrained by the speed of sound. Optical systems, in which light-emitting diodes (LEDs) on the ceiling or headset signal their whereabouts to photodetectors, work only in a clear line of sight; they can be disrupted if a head tilts too far or a waving hand blocks the light. And they require elaborate equipment—a headset outfitted with four cameras and a ceiling studded with LEDs. Both acoustic and optical trackers suffer from range restrictions.

Enter the inertial tracker. With funding from NASA, Foxlin has spent the last three years developing a prototype that senses the orientation of a person's head the way an autopilot senses that of an airliner: with gyroscopes. Built into a palm-sized plastic block that attaches to the top of a head-mounted display are three tiny solid-state gyros, one each to detect changes in pitch, yaw, and roll. Because the gyros measure angular changes directly, rather than in consultation with fixed emitters or receivers, Foxlin's tracker requires only a fraction of the processing time of conventional trackers—about one millisecond. It also is immune to the magnetic and acoustic interference that plagues trackers based on those forms of energy, so images are much steadier.

Another advantage of being self-contained is the tracker's virtually limitless range. Conducted in a large gymnasium or the great outdoors instead of within the narrow ambit of ultrasound detectors and other sensors, virtual reality could become an ideal training tool for sports, firefighting, or military maneuvers, Foxlin predicts.

Not by Gyros Alone

But gyroscopes by themselves are not a perfect solution. For one thing, the small, inexpensive solid-state devices in Foxlin's tracker are far less accurate than the bulky, high-priced gyros that guide planes and missiles; errors accumulate, causing the readings to drift three degrees off the mark each minute. To compensate, the tracker contains a compass and an inclinometer (basically a carpenter's level), which periodically take reference readings. Each time the user's head is still for a few moments, the tracker slowly resets itself to the orientation shown by the compass and the inclinometer.

A worse deficiency of gyros relative to conventional trackers is that they can't monitor your position—your actual

PHOTO: MARK OSTOW

location in space, as opposed to simply the angle of your head. If you hold your head still, you can take 10 paces forward wearing a gyro-based tracker, and the scene on your head-mounted display will remain stationary. In the inertial navigation systems used in various vehicles, position is tracked by means of accelerometers, which measure changes in speed—and indeed Foxlin plans to integrate such devices into his unit soon. But, he says, position is harder to calculate accurately than orientation; errors tend to multiply as acceleration is translated into velocity and as velocity is then translated into position.

While Foxlin works it all out, his system tracks the user's position by an age-old method: cheating. It incorporates an off-the-shelf acoustic beacon that calls to a trio of ceiling-mounted microphones. The miracle of triangulation does the rest. Although this approach reintroduces range limits and other problems his tracker was meant to solve, Foxlin finds it a satisfactory stopgap. "It adds some jitter and delay," he says, "but humans are much less sensitive to these when they affect position instead of orientation."—*DAVID BRITTAN*

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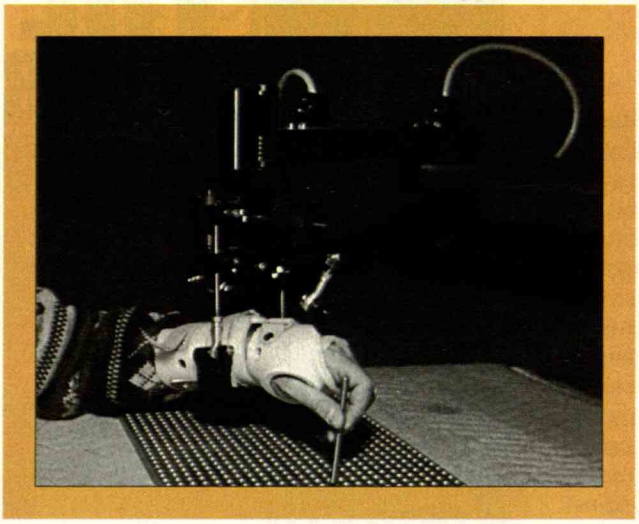
ROBOTIC THERAPY

After people suffer a stroke, the kind of rehabilitation therapy they receive for any resulting paralysis falls in a range between two extremes. Some physicians and therapists, believing that undamaged portions of the brain can be trained to take over the function of the injured areas, may suggest that patients try to coax whatever movement they can from immobilized limbs. Other rehab professionals, however, may recommend that patients learn to use unaffected parts of the body as replacements for performing basic tasks. Sadly for stroke victims, the medical community has not been able to prove just what kind of exhausting therapy produces the best outcome.



A robot supporting a wrist and lower arm can reproduce movements a therapist might make to exercise an arm paralyzed by stroke.

Neville Hogan, professor of mechanical engineering and brain and cognitive sciences at MIT and director of the Newman Laboratory for Biomechanics and Human Rehabilitation, hopes to resolve this uncertainty with a robotic device that he, along with Andre Sharon, associate director of the Laboratory for Manufacturing and Productivity, and mechanical-engineering graduate student Jain Charnnarong, has been developing. The machine, which includes a brace that supports a person's wrist and lower arm and can reproduce a therapist's movements, could produce quantitative information on the effects of exercising paralyzed limbs. Such information would help not only the thousands of people who annually suffer strokes and end up with arm paralysis (there are 3 million stroke survivors in the United States) but might also prove useful for the large numbers of people with neurological problems such as Parkinson's disease, multiple sclerosis, and spinal-cord injuries.

Initially the machine's brace, outfitted with sensors that measure movement, records the way a moving arm travels horizontally (for stroke patients, a therapist holds the limb) and how the hand rotates. The device's computer can then send signals to high-performance motors connected to the brace, which reproduce the motions and thus take over for the therapist during exercises. As patients resume some of their ability to move injured arms, the computer can sense the changes and direct the motors to alter their resistance.

In preliminary tests conducted at Burke Rehabilitation Center in White Plains, N.Y., patients with varying disabilities "love" the machine, says Mindy L. Aisen, a neurologist and the center's chief of spinal-cord injury, partly because it guides them through exercises in which they learn to manipulate video-game images on a screen. The computer rewards their success with visual and aural feedback.

Hogan's team also hopes that the machine will help quantify what is happening in the brain of someone with a neurological disability affecting arm movements. Some early research on this problem is taking place at Massachusetts General Hospital in Boston. There the robot has started to be used with a positron-emission technology (PET) scanner, an instrument that can produce images of brain-cell activity. Researchers hope to periodically produce pictures showing what is happening in the brains of stroke patients who use the robot over weeks or months, and compare the images with PET scans of stroke patients who have exercised their "good" arms rather than damaged limbs.

Aisen sees the robot as a possible "ancillary tool" for traditional therapy, partly because it can quantify how much a person can move an arm following a neurological problem affecting motor abilities. Today, neurologists generally must make subjective analyses—eyeballing, for instance, the speed with which patients can form a circle with their thumb and opposing finger.

George Kondraske, a professor of electrical and biomedical engineering and director of the Human Performance Institute at the University of Texas, Arlington, says devices that measure motor activity can help patients gain motivation to continue therapy, if specialists update them on the numerical results. Noting that such "human-performance measurement" machines are being developed for other applications as well, such as determining the effects of new drugs on patients, Kondraske points out that the devices can also be useful for indicating when someone has plateaued with a certain therapy.

What Aisen calls the "profound" drawback of the Hogan team's robot—that it can work only with the larger joints in the arm, meaning the wrist, elbow, and shoulder—is something Hogan says he hopes to overcome. Enabling the machine to work with individual fingers on the hand is "very much in the plans," he says. Other ideas include developing the instrument to move the arm along the vertical plane and provide a greater range of motion to the shoulder.

Meanwhile, Hogan team members are testing whether the robot could have other uses. Employing it as a simulation tool, postdoctoral associate Michel Lemay is trying to evaluate various powered braces that move elbows and shoulders in arms that have been made motionless by spinal-cord injuries. (Therapists do not try to retrain people after such injuries, since limbs cannot be made to work again.) And with doctors at Burke Rehabilitation Center, Hermano I. Krebs, a graduate student in ocean engineering who is interested in robotics, has started using the robot with Parkinson's disease patients taking the drug L-dopa to reduce characteristic tremors. Since the device can measure the extent to which an arm moves, the researchers reason, it might indicate how long a dose of medicine is effective in an individual. Noting that similar studies could be conducted with multiple-sclerosis patients, Hogan says, "The perception of the machine's possible applications changes as we use it."—*LAURA VAN DAM*

PHOTO: DONNA COVENEY

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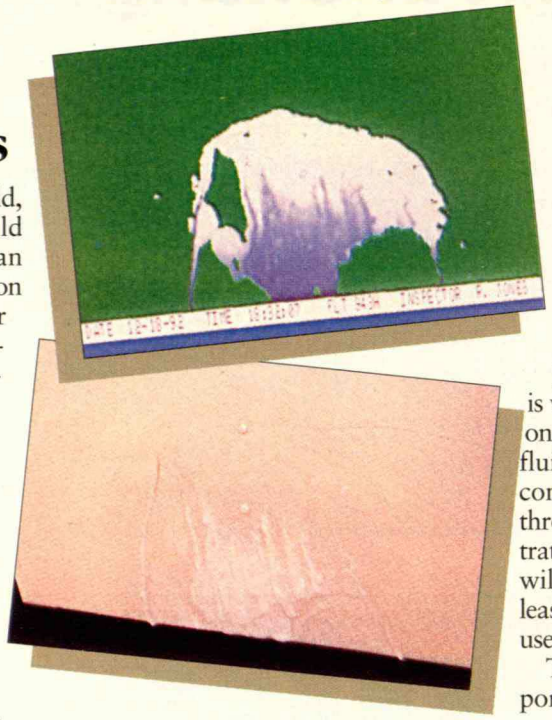
Trends

Deicing in the Wings

During the depths of winter's cold, few people wish that they could make snow and ice vanish more than airplane pilots. When ice accumulates on an aircraft's wing, it alters air flow over the wing, which suddenly may not create as much lift as its designers intended, or as its pilots expected.

The results can be disastrous. Last November's crash of a dual-engine American Eagle turboprop, in which 58 people died, has been blamed on ice that accumulated on the aircraft's wings during flight. A USAir jet that crashed on takeoff three years ago at New York's LaGuardia Airport, killing 27 people, was linked to ice as well.



That accident made the Federal Aviation Administration the focus of blistering criticism for having inadequate ice-prevention regulations. As a result, the agency has devised a set of charts, known as "holdover tables," that specify the conditions under which planes need to be deiced. And researchers have been developing new methods to help airports perform deicing operations more effectively.

Airport workers now spray deicing chemicals on an airplane before it starts taxiing down the runway. The deicers come in two categories: Type I chemicals use propylene glycol or ethylene glycol (a common ingredient in antifreeze) to remove whatever ice is on the wings. The problem is that these deicers dissipate relatively quickly and in icy conditions may have to be reapplied if the airplane sits on the ground for even a few minutes, depending on conditions. Type II fluids also use ethylene or propylene glycol, but include a thickening agent that usually enables them to adhere to the wing for about 30 to 35 minutes.

Before the LaGuardia crash, U.S. airlines used Type I fluids almost exclusively because they are less expensive. But the FAA has since required wider use of Type II fluids.

Now researchers are unveiling new deicing fluids that could allow aircraft to go even longer without being resprayed. For example, Union Carbide Corp. is touting a higher-viscosity anti-icing product known as Ultra. Under simulated freezing conditions, the chemical, which contains a proprietary thickening agent, forms a thick layer on the wing. According to the company, it is able to prevent the formation of ice and snow for as long as 80 minutes.

The product has caught the FAA's eye. "It appears to have a greater time of effectiveness," says Charles Masters, who heads the agency's Aviation Safety Program. But before it can approve the fluid, the FAA must gather more data on how it holds up under actual conditions, he says. "That will be one of our main efforts this year."

Unfortunately, Ultra may have an Achilles' heel. Like other deicing fluids already in use, its key ingredient is ethylene glycol, which is toxic and uses up oxygen needed by living organisms in lakes and streams. Because the Environmental Protection Agency and other environmental groups have been pushing airports to reduce glycol-tainted runoff, managers have been developing techniques for recycling glycol-laden deicing agents and have been clamoring for deicing chemicals without any glycol.

That's where another fluid, developed by researchers at NASA's Ames Research Center in California, may come in handy. Though NASA researchers won't divulge details until after they apply for a patent in the near future, they say the fluid contains no glycol, and that it contains a polymer that makes it thick and viscous enough to adhere well to an airplane wing.

John Zuk, an engineer at Ames who is working on the project, says NASA is on the verge of granting a license for the fluid to an unidentified Fortune 500 company, which would shepherd it through the battery of tests and demonstrations that are required before the FAA will approve it. Still, it will likely be at least two years before the fluid will be in use on commercial airliners, he says.

The fluid could also be used on airport runways, which have to be deiced as well. Many airports now spread urea on runways as a deicing agent because it is inexpensive and acts like salt, lowering the melting point of ice. But urea decomposes into ammonia and fosters growth of algae in lakes and streams, Zuk points out. Alternately, the U.S. Air Force and some airports have experimented with runway deicers based on acetates, salts made from acetic acid, or vinegar. But he says the chemicals form ions whose electrical charges have been implicated in electrical short circuits in Air Force F-16 jets.

Ice-Detection Devices

To use any deicing chemical, a pilot has to know whether any ice or snow has accumulated on a plane's wings. At present, there's only one way to tell: for the pilot—or someone else—to look. But because of where the pilot sits, he or she usually can't see the whole wing.

New devices may make ice detection easier. One being developed under an FAA contract by Robotic Vision contains an optical sensor that detects ice, snow, slush, or frost. A screen displays an image that enhances the contrast between the wing surface and any such precipitation, which otherwise may not be readily apparent to the naked eye. Moreover, the sensor can "see through"

PHOTOS: RVSI

To help pilots determine when to apply deicing chemicals, the FAA is funding development of an optical sensor that can detect hard-to-see accumulations of wing ice (bottom left), and a screen display that boosts the contrast between the ice and the wing surface (top left).

deicing fluids, hydraulic fluids, and aviation fuel that may have been sprayed or spilled on the wing.

Researchers at Denver's Stapleton Airport are conducting tests this winter at a ground station where workers will use the device to inspect planes before takeoff. Eventually the scanner could be mounted on the plane itself so the pilot could check the wings using closed-circuit television.

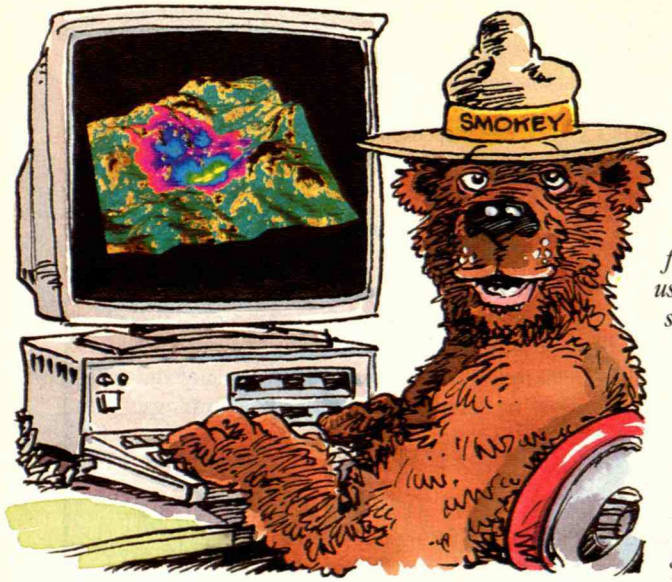
At the National Center for Atmospheric Research in Boulder, Colo., researchers are focusing on another aspect of the aircraft icing problem: helping pilots determine exactly when to respray a plane with chemicals once it has already been deiced. The FAA's holdover tables specify how frequently a plane needs to be deiced under various conditions, but to use them, a pilot must know the precise kind of precipitation and how much has fallen on the airplane, says Roy Rasmussen, an atmosphere scientist at NCAR.

That's not always obvious. In the LaGuardia crash, for example, the flight crew apparently underestimated the snowfall rate, because, Rasmussen theorizes, visibility may not have been as poor as in other storms. Relatively large but seemingly fewer flakes were falling, he suggests.

To develop a more reliable way of estimating precipitation, Rasmussen and his colleagues set out a network of automated snow gauges at the Denver airport. The gauges calculate snowfall by catching and melting the flakes in an ethylene glycol solution and measuring changes in the solution's weight. They plan to use the results to calibrate Stapleton's weather instruments so that radar data could be used to estimate how much precipitation has fallen on planes.

The experiment is being extended this winter to Chicago's O'Hare Airport. United Airlines is using the system at both locations to help guide decisions on when planes need to be deiced and runways plowed. By next winter, Rasmussen thinks, O'Hare might be the site for the first operational system.

—*Vincent Kiernan*



Only you can prevent forest fires, but only forest managers using new fire-growth modeling software can accurately predict how fast and how far a blaze will spread once it has started. This model of a recent fire in Yosemite National Park showed how the existing flames (yellow) would spread during successive time intervals (represented as green, blue, purple, and red).

Modeling Forest Fires

Last summer, as wildfires roared through millions of acres of forests in California and several other western states, firefighters frantically checked prevailing wind conditions and measured the moisture content of trees adjacent to the blaze to try to estimate its potential speed and direction. This year they may have a faster, more accurate method at their disposal.

Mark Finney, a researcher with the U.S. Forest Service's Intermountain Fire Sciences Laboratory in Missoula, Mont., has developed a computer model to calculate how a fire will grow based on local weather, topography, and vegetation. With Finney's model, known as FARSITE (Fire Area Simulator), fire managers in national parks and forests will be able to type the location of a fire into a personal computer and immediately see a map depicting the anticipated spread of the flames at different time intervals. The managers can then decide whether to let the blaze burn itself out or send in firefighters to prevent it from spreading.

The need for an accurate fire-growth model intensified in 1988, when wildfires devastated much of Yellowstone National Park in Wyoming. After the blaze had finally died out, the National Park Service required park managers to provide comprehensive fire-fighting plans, including more precise methods of predicting how fires in their jurisdiction might spread.

But many of the early attempts at using computers to model fire growth yielded crude and distorted results because they assumed that blazes move mechanically on a regular grid from one square or hexagonal cell to another. "You will get tremendous distortion if you try the cellular approach," says Finney. "Fire doesn't spread as a discrete process."

Instead, Finney looked to the seventeenth-century Dutch physicist Christian Huygens for inspiration. Huygens studied the propagation of waves and was the first person to convincingly describe the wave behavior of light. "Huygens's principle" shows how each point on a wave front expands outwardly like a balloon into a shape that can be defined as an ellipse. Each point on the ellipse, in turn, serves as a source of new, secondary waves, and so on.

Finney used Huygens's equations to model the spread of a fire from points along its edge, defining the parameters of the ellipse according to the type of fuel for the fire, the slope of the terrain, and meteorological conditions of the area. After fire managers type in the location of a blaze as well as wind speed and direction into a personal computer, the model draws on a database containing information on the area's slope, elevation, fuels, canopy density, and other factors to compute new positions of points along the fire's perimeter.

Several researchers developed similar wave-growth models during the 1970s, but detailed information on the terrain of parks and forests was scarce. And only recently have personal computers gained the power and speed necessary to continuously model the fire's spread.

Jan van Wagtendonk, a fire scientist at Yosemite National Park in California, and several other researchers used FARSITE to track the progress of a small fire last summer near Glacier Point in Yosemite and were impressed with its accuracy. The model, which also proved its ability to estimate the spread of small blazes in Sequoia and Kings Canyon national parks in California, is scheduled to be available to fire managers in national parks in early 1995.

Refining the Model

Still, there is room for improvement. In early tests, the model consistently overestimated the growth of larger fires because it failed to account for minor fluctuations that could slow a fire if, for example, it had to traverse a grassy patch between trees or if swirling winds blew the flames anywhere except in the direction of unburned fuel. For long-burning fires that travel long distances, these minor fluctuations add up, explains Finney. Thus he is currently refining equations in the fire-growth algorithm to account for such complex small-scale variations.

Although the model has been tested only on carefully watched natural fires in the national parks and national forests, it might eventually be used to predict the spread of wildfires, such as those that burned through western states last summer, virtually anywhere. But that would require an expanded database: although fire managers can now enter the elevation and slope of any given area based on information from the U.S. Geological Survey, knowledge of fuel types and their density is incomplete, especially for remote areas. To remedy this, Van Wagtendonk and other Yosemite scientists are attempting to develop a reliable method of relating satellite images to vegetation types, so scientists would not have to slog through miles of forest to determine which areas are covered, for example, by tall trees, low shrubs, or grass.—*ALEXANDRA M. WITZE*

ILLUSTRATION: JON McINTOSH; PHOTO: MARK A. FINNEY

AIDS Vaccines and Ethical Dilemmas

Though still a long way from being perfected, dozens of AIDS vaccines are moving steadily through the development process. At least 15 vaccines intended to protect people from becoming infected with the HIV virus are being evaluated in the United States alone, and at least 10 more therapeutic vaccines designed to prevent full-blown AIDS in people already infected are also in the works. (*See "Confronting the AIDS Vaccine Challenge" by Max Essex, TR October 1994, page 22.*) All the trials have so far been conducted on animals or very small numbers of human participants. But sooner or later, vaccines will have to be tested on thousands of people to determine their effectiveness.

As researchers edge closer to this stage, however, they are finding that the difficult questions concerning HIV vaccines go beyond their medical efficacy. "The issues have turned from the purely scientific to ethical, political, and economic," says Carol Levine, an AIDS policy specialist and executive director of New York's Orphan Project, which develops programs for children with parents dying of AIDS.

Among the most important considerations when evaluating a trial for a preventive AIDS vaccine, says Levine, is ensuring that trial participants realize that the vaccines are experimental and therefore may not provide protection against HIV. Participants also must be aware that some are receiving a placebo.

"No matter how often that message is repeated, history shows that people in experimental trials tend to believe that what they are getting is useful, or science would not be giving it to them," Levine says. That can be particularly dangerous with an AIDS vaccine. "If people feel a false sense of security, they're likely to lapse into riskier behavior that ultimately could end up costing them their lives."

Of course, before patients can scrupulously avoid such pitfalls, they first must be informed of the risks. But Arthur Caplan, director of the Center for Bioethics at the University of Pennsylvania, cautions that in their zeal to test a vaccine, doctors and researchers may intentionally fail to deliver adequate warnings: the more they educate subjects, the less likely the latter are to practice risky behavior, and thus the less effective they are for testing the vaccine's efficacy. He proposes that the educational element of a trial be administered by an independent team so scientists are not forced to choose between the advance of science and the health of individuals.

A related concern is how to test vaccines that may be only partially effective. The preventive vaccines now under investigation are considered 30 to 70 percent effective against HIV transmission. While they may reduce the statistical likelihood of infection, they do not provide a guarantee. "It's still a roll of the dice, and you're right back to the questions of false security and diminished vigilance," says Caplan. "If you're going to use a partial vaccine, you've got to make sure you redouble your education and prevention efforts or you could end up with an even bigger threat to public health."

Another major concern is the need to protect both the health and civil rights of those who volunteer to be test subjects. Amy Sheon, a specialist in designing trials for the AIDS Division of the National Institutes of Allergy and Infectious Diseases (NIAID), insists that "there is absolutely no possibility of becoming infected from any vaccine NIAID is testing," because all but one are made from only bits and pieces of the HIV virus. The version developed by Jonas Salk is made from a whole virus but uses just the shell of the HIV molecule after it has been killed with gamma radiation to ensure that it is inactive, she says.

Yet while patients don't become infected with HIV, some vaccines can cause them to test positive to HIV antibodies, which can lead to problems such as cancellation of their health insurance. Sheon suggests a way to deal with this: issue a special identification card and number to each volunteer. Under this approach, which has been tried with some success in small-scale trials, a test subject could present the card to an insurance company or employer, for example, who could then call an 800 number and verify that the individual is involved in an AIDS vaccine trial.

Such programs may offer only minimal protection, however. "If a person tests HIV-positive, even if he or she is not infected, the public perception is going to be that this person has AIDS," Caplan asserts. "We cannot protect people from all the social discrimination so often associated with AIDS. This is

In countries where AIDS is epidemic and treatments are unavailable, people may be more willing to accept the risks of vaccine testing than residents of industrialized nations.

CUMULATIVE HIV INFECTIONS AS OF JANUARY 1

	1994	1996
NORTH AMERICA	1,138,000	1,286,000
WESTERN EUROPE	660,000	838,000
OCEANIA	27,000	32,000
LATIN AMERICA	1,313,000	1,556,000
SUB-SAHARAN AFRICA	15,459,000	19,222,000
CARIBBEAN	402,000	503,000
EASTERN EUROPE	28,000	34,000
SE MEDITERRANEAN	58,000	73,000
NORTHEAST ASIA	94,000	181,000
SOUTHEAST ASIA	3,020,000	9,605,000
TOTAL WORLD	22,200,000	33,330,000

CHART: GLOBAL AIDS POLICY COALITION

something they should be made fully aware of when they agree to participate in a vaccine trial."

Perhaps the biggest controversy arises when researchers consider conducting trials in developing countries. From a scientific perspective, developing countries hit hard by AIDS are often better testing grounds for a preventive vaccine than most U.S. populations, because even among U.S. groups considered at high risk for HIV, the annual infection rate is no more than 2 percent per year. NIAID estimates that with such infection rates, some 5,000 trial participants would be required for a two-year trial. A similar trial in a country with a 5 percent infection rate would require only 2,000 participants to achieve the same scientific results.

But scientific considerations do not eclipse the ethical and moral obligations entailed in testing abroad. "Some people feel there shouldn't be testing overseas if there isn't large-scale testing going on here," explains Sheon. "They worry that subjects in developing countries could be more easily exploited."

Concerns about testing in developing countries were highlighted in October when the World Health Organization announced plans to carry out full-scale trials of two AIDS vaccines—possibly beginning as early as 1996 in Thailand and later in Brazil and Uganda—after NIAID announced it was suspending similar tests in the United States.

Patricia Fast, an immunologist at NIAID, maintains that one must consider the local calculus of risks and benefits for any given geographical area. In developing countries, where AIDS may occur in epidemic proportions and some treatments may not be available, people may be more willing to take the risks associated with vaccine testing than citizens of the United States and other industrialized nations.

Caplan concurs that each country must be allowed to devise its own risk-benefit ratio, maintaining that "It would be shortsighted and paternalistic for activists to say they are protecting people in developing countries by keeping test vaccines from them."

Indeed, the sense of urgency in parts of the world hit hardest by AIDS is growing. The World Health Organization estimates that some 17 million people worldwide have contracted HIV, and more than 4 million have developed AIDS. Nearly half of those infected live in Africa. In Uganda, AIDS is responsible for 50 percent of all deaths, and for 90 percent of deaths among people under 35 years of age. Infection rates have risen tenfold in Thailand since 1990.

"When you're up against a plague of such proportions, you've got to take definitive action," argues Caplan. "These countries don't have the kind of medical treatments that people in the United States can opt for until safer, better vaccines are available. You don't throw your ethics out the window, but you reassess your criteria."—*MUBARAK DAHIR*

The Lowdown on Blacktop

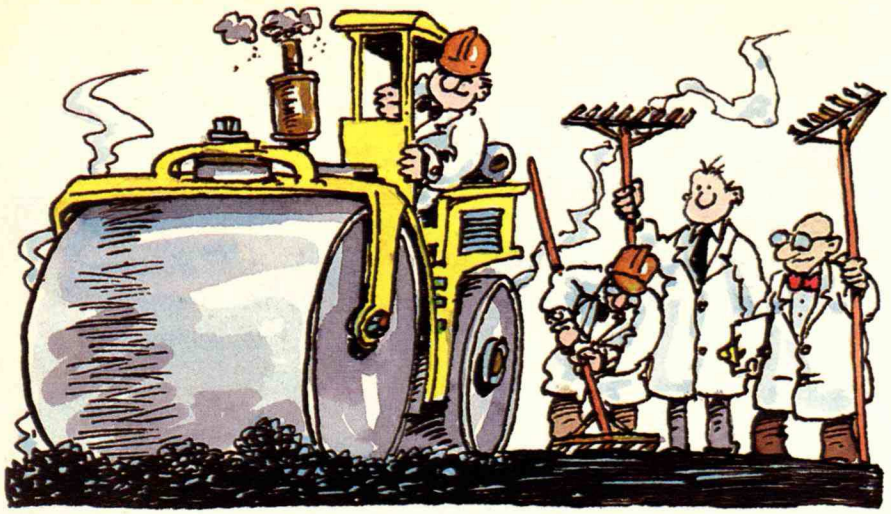
With some 5,000 years of experience in the use of asphalt worldwide and more than 2 million miles of paved roads in the United States alone, one might imagine that the tar-like substance had long since surrendered the last of its mysteries. How else could highway builders predict when an asphalt mixture was too soft, resulting in roads that develop ruts under the weight of heavy traffic, or too stiff, leading to cracks and potholes?

The fact is, until recently asphalt producers have had no theoretical way to predict performance. Trial and error has dominated the road-building enterprise to a surprising extent. Even asphalt's chemical composition and structure have become well understood only within the past decade. "It's hard to believe but true," says Neil F. Hawks, director of special programs at the Transportation Research Board, in Washington, D.C. "Nobody had really ever sat down and taken asphalt apart until the mid-1980s."

Now, advances in understanding the structure and mechanics of asphalt roads—a sticky black organic material distilled from petroleum mixed with an aggregate, chiefly sand or gravel—are moving from the laboratory to the street as a result of a five-year, $50 million U.S. government research effort called the Strategic Highway Research Program (SHRP).

The bulk of techniques needed to understand and improve the performance of asphalt—from modeling chemical constituents to testing stress—were pioneered in the plastics industry as early as the 1950s. Why, then, was the asphalt industry so slow to adopt them? Hawks contends that the material's origins as a natural rather than manufactured product help explain why it has been taken for granted for so long.

"Asphalt has a long history," Hawks says, "but it has always been thought of as something that just is—like sin." In fact, naturally occurring deposits of



asphalt are believed to have been used in construction throughout recorded history. Early Buddhist texts mention "earth butter," and asphalt is known to have been used to seal the brick walls of a reservoir in India as early as 3000 B.C. Even in modern times, Hawks notes, asphalt is derived primarily as a waste product of oil refining—another reason for the lack of scientific attention.

Also important is the fact that, especially in the United States, traditional asphalt paving techniques, passed down through generations, have worked well overall, yielding a durable and sturdy network of roads. But glaring problems began to crop up in the late 1970s.

Not only were road builders faced with ever-growing traffic demands, but they were also for the first time forced to deal with widely divergent sources for asphalt. In response to the energy crisis of the 1970s, U.S. oil companies began to import petroleum from many different regions, including Alaska and the North Sea. The differences led to variations in asphalt. And road builders, relying on past experience to gauge the quality of their mixtures, often wound up with highway ruts and deformations only a year after a road had been built or refurbished.

With some 250 billion tons of asphalt covering the nation's network of roads, the chance that rebuilding would be plagued by rutting and cracking was simply too big a problem to ignore. Against this backdrop, Congress authorized the SHRP to rationalize the road-building process and improve asphalt's performance.

The government dispatched dozens of engineers and chemists around the country to study what makes asphalt resilient and strong. The researchers studied the characteristics of the aggregate and the chemical composition of asphalt from various sources and classified how subtle differences could affect road durability.

The research yielded some surprising results. For example, it had been widely assumed that finer gravel or sand would allow a more compact mixture that would better withstand rutting. But Carl Monismith, an engineer at the University of California at Berkeley, discovered that larger-sized gravel resists rutting more effectively because big stones are more likely to make contact with each other in pavement, thus creating a stronger skeleton for carrying heavy loads than small pebbles, which may simply float independently in the tar-like goo. His work has already led to the use of larger aggregate in asphalt mixtures in most areas.

Asphalt-Mixing Software

The overall outcome of the SHRP research was a set of specifications for asphalt mixing called Superpave, a procedure that employs computer software to help take the guesswork out of road building. The program asks road builders to enter the geographic location and anticipated traffic characteristics. An algorithm taps a database that provides meteorological information according to geographic location and computes not only the extreme temperatures the pavement will have to withstand, but also how long it will have to endure them. Based on this information, Superpave determines specifications for an asphalt mixture stiff enough year-round to resist rutting in the heat of the summer, yet resilient enough to resist cracking.

Still, because asphalt is an organic material it may exhibit subtle differences even when obtained from the same source. Thus, for roads that must withstand heavy traffic and widely fluctuating temperatures, Superpave mandates laboratory tests to verify that the mixture prescribed by the Superpave software performs adequately. Fortunately, the SHRP research also led to a series of fatigue, crack, and other stress tests that can be used for this purpose. One long-term fatigue test, for example, subjects the asphalt mixture to 20 hours of high pressure to determine long-term wear.

So far, less than 2 percent of the nation's roads have been built or refurbished using Superpave techniques. But most administrators see promise for the program. In fact, the Federal Highway Administration is lobbying to purchase the needed $230,000-laboratory equipment for each state so the whole country can adopt Superpave.

Nonetheless, many in the industry maintain that while Superpave's predictive abilities should help pavement last longer, materials alone cannot guarantee a well-made road. Road building is as much an art as a science, says Paul Webster, director of marketing at the National Asphalt Pavement Association.

Webster heads up the committee that confers an annual award for the country's best new or rebuilt road, the most recent of which was bestowed on Interstate 440, a reconstruction project in Raleigh, N.C. Contest judges look at "overall craftsmanship," he says, including the smoothness of the road surface and the longitudinal and transverse joints where one batch of pavement meets another. "The process of making asphalt roads is like baking a cake," says Webster. "The precision and technology we're using today were unthinkable even two generations ago, but the ingredients and craftsmanship required by the practitioner in the field haven't changed for a millennium."—*SETH SHULMAN*

ILLUSTRATION: JON McINTOSH

Hyenas Yield Clues to Human Infertility, Aggression

Hyena pups start attacking each other soon after taking their first breath and usually kill one sibling per litter. Researchers suggest that unexpectedly high levels of a hormone once thought insignificant may explain not only the pups' hostile behavior but also aggression in teenage girls who have elevated levels of the same hormone in their bloodstream.

Female spotted hyenas are nothing less than bizarre. They mate awkwardly and give birth through a pseudopenis. They grow larger and are more ferocious than males. And they always outrank males in the hyena clans.

For the last 10 years, researchers have been slowly unraveling the reasons for the female hyena's strange physiology and behavior. Along the way, they have identified the first clear case of sexual characteristics transmitted from mother to offspring through hormones circulating in the blood, instead of through the mother's genes. The findings, they say, may shed light on a type of human infertility and aggressive behavior in some women and girls.

Two researchers from the University of California, Berkeley, psychologist Stephen Glickman and behavioral ecologist Laurence Frank, began studying hyenas in 1985 after capturing hyena cubs in Kenya and creating the world's only captive hyena colony in an uninhabited stretch of hills above the Berkeley campus. Since then, the hyenas have handed the scientists one surprise after another.

Working with Paul Licht, an endocrinologist at the university, the group was handed its first jolt when experiments revealed that the ferocious adult females had less male sex hormone testosterone in their blood than males, not more, as had been thought. Instead, the females had significantly elevated levels of androstenedione, a hormone found in all mammals, both male and female, including humans. Before its discovery in hyenas, scientists had dismissed androstenedione as an insignificant intermediary hormone. Unless it was acted upon by enzymes that changed it into androgens—male sex hormones such as testosterone or female sex hormones such as estrogen—they thought it had no effect. To further complicate the issue, the researchers found that during pregnancy, female hyenas suddenly did contain unusually high levels of testosterone in their blood compared with that of males.

To unravel these mysteries, the group enlisted the aid of several other researchers, including Tamer Yalcinkaya, an obstetrician at the Department of Obstetrics and Gynecology at the West Virginia University School of Medicine, and Pentii Siiteri, an endocrinologist at the University of California School of Medicine, San Francisco, where more studies on female hyena physiology were conducted.

When the results came in, the scientists knew they had stumbled upon two important discoveries. First, they learned that the androstenedione was being produced in the hyenas' ovaries rather than the adrenal glands, where the hormone is normally made. Second, they found that the placenta, which provides nutrition for developing fetuses, was changing the androstenedione made by the ovaries into testosterone.

The research team discovered that during the entire 110 days of gestation, the bloodstreams of the female and male fetuses are deluged with increasing amounts of male sex hormone. While the male sex organs are seemingly unaffected, the female's clitoris transforms into a pseudopenis that grows larger than a male penis, and her labia transform into what look like scrota, but are only fibrous-fatty tissue.

Brian Hall, a researcher at Dalhousie University in the Canadian province of Nova Scotia, said the hyena findings are remarkable. "We think of sexual characteristics as something controlled by the sex chromosomes that the individual has inherited, or by the sex hormones that an individual produces," he says. "Yet in this case, they're being controlled by the sex hormones that the mother produces."

The researchers showed that spotted hyena placentas produce huge quantities of an enzyme that changes androstenedione to testosterone. But hyena

PHOTO: STEPHEN B. GLICKMAN

placentas have little of an enzyme called aromatase that changes androstenedione to estrogen—only one-twentieth the amount in human placentas. The researchers concluded that the spotted hyena's ovaries and the placenta act together to generate high levels of testosterone, which cause female fetuses to grow the male-like sex organs at the time of sexual differentiation in the womb.

Challenging Hormone Theories

The abundant testosterone probably has one more highly significant effect. It stunts the ovaries, which develop while female hyenas are still in the womb, says Siiteri. The hyenas are thus born with fewer eggs and more stromal tissue, in which the eggs are imbedded, than is normal in most female mammals. Typically, at sexual maturity, the stromal tissues produce minuscule amounts of androstenedione that are changed into estrogen by a layer of tissue that immediately surrounds the eggs. But because female hyenas have so much stromal tissue, an abundance of androstenedione is produced during their entire adult lives, which is why scientists first measured it in high levels in their bloodstreams.

The hyena research may provide insight into one cause of human infertility, polycystic ovarian disease. Women who have the disease have great difficulty becoming pregnant because they have few eggs in their ovaries. The cause of the disease is unknown, but some scientists now speculate it may be related to a hormonal imbalance because, says Siiteri, the ovaries of women who have the disease look just like hyena ovaries.

Similarly, a study published by Japanese researchers in 1991 reported that a human female fetus developed male sex organs when a genetic mutation resulted in an inactive aromatase enzyme in her mother's placenta. "The woman's placenta was acting just like a hyena's," says Glickman.

While scientists understand the physical changes brought about by increased hormone levels in female hyenas, the reasons for the mammal's unique behavioral profile are not so clear. The researchers speculate that the high levels of testosterone during pregnancy lead to the birth of aggressive pups that begin attacking their siblings immediately after taking their first breath. The strident behavior, which usually results in one pup death per litter in the wild, slacks off after a couple of weeks as testosterone levels drop. But for some reason the females continue to be more aggressive.

Elizabeth Sussman, a developmental psychologist at Pennsylvania State University, found in previous research that very aggressive teenage girls had higher levels of androstenedione than less aggressive girls, which suggests that the hormone may somehow directly influence aggression. She had assumed that stress was causing the adrenal glands to produce the androstenedione.

But, says Glickman, "the androstenedione may be coming from the ovaries rather than the adrenal glands, and it could be having an effect on behavior after it's converted to estrogen or testosterone in the brain." And therein lies the ultimate mystery: how hormones affect the brain.

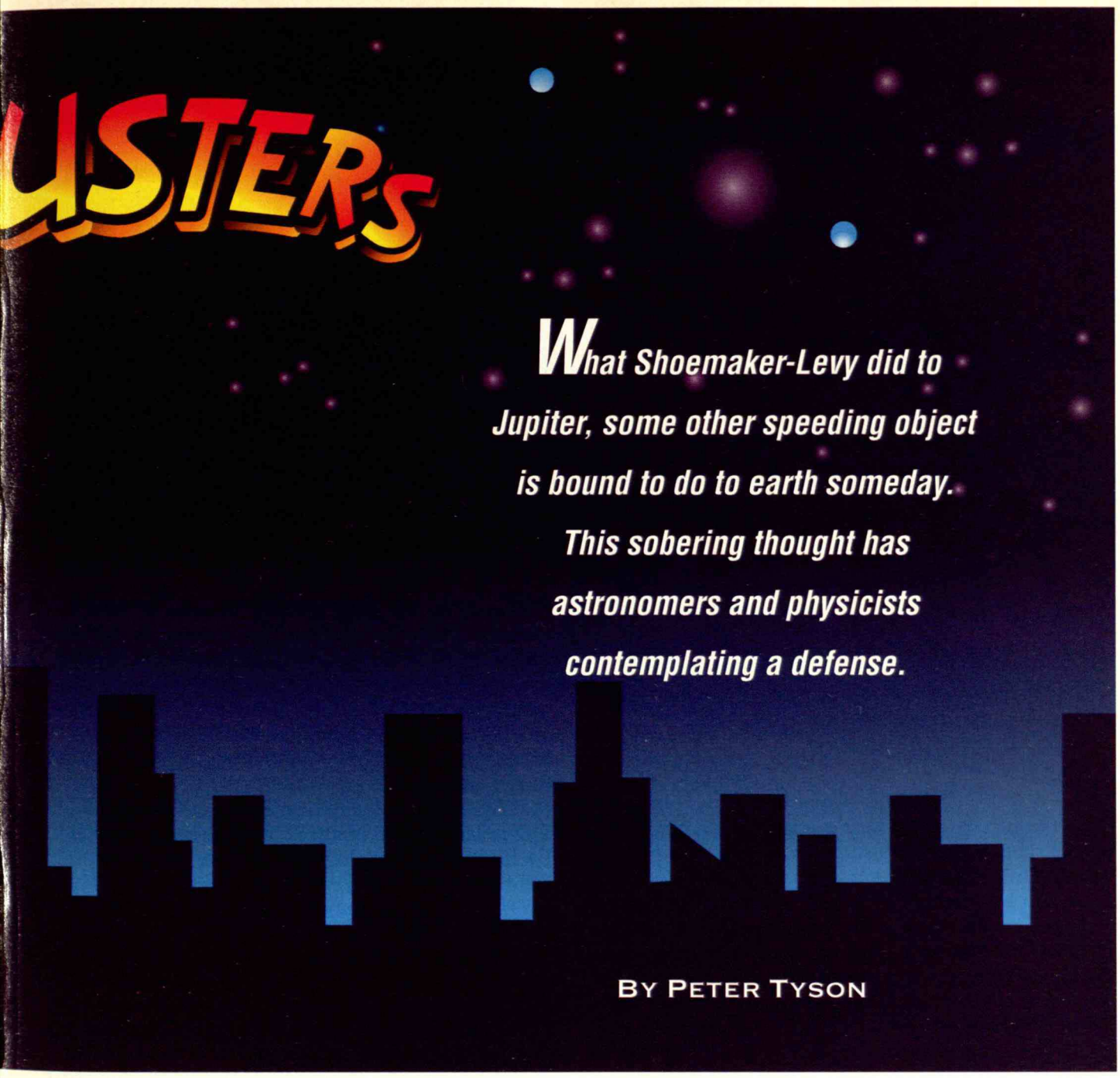
Roger Gorski, a neurobiologist at the University of California, Los Angeles, says that although the female hyenas can still mate and bear young, that isn't always the case in other species when the females develop male characteristics. For example, adult female rats that have been exposed to excessive male hormones while still in the womb display male mating behavior and cannot ovulate.

The hyena findings "certainly challenge the basic hormone concept, because here we've got enough male hormones to masculinize the female genitalia and perhaps even masculinize the aggressive behavior of the animals, but still they are fertile," Gorski says. "That doesn't fit." The next question to answer, he says, "is why, unlike in rats, the female hyena brain does not become completely masculinized."

—*JANE E. STEVENS*

NOT LONG AFTER the constituents of Comet Shoemaker-Levy 9 riddled Jupiter last July, my nine-year-old stepson and I watched the 1979 movie *Meteor*. In the film, NASA officials discover that an asteroid eight kilometers wide will hit the earth in five days, unless the superpowers can put their Cold War differences aside and stop it with a combined force of space-based nuclear missiles. The incoming asteroid is preceded by a band of advance henchmen: one meteorite sparks a tsunami that floods Hong Kong, another triggers avalanches that bury a Swiss village, yet another scores a direct hit on New York City. My stepson "wowed" when this last projectile gouged out Central Park and destroyed the World Trade Center (twice, in case you missed it the first time). As screaming New Yorkers fled from tumbling buildings, my stepson said, "Those traffic signs shouldn't say Walk, they should say Run!"

Fortunately, we have more at our disposal than



What Shoemaker-Levy did to Jupiter, some other speeding object is bound to do to earth someday. This sobering thought has astronomers and physicists contemplating a defense.

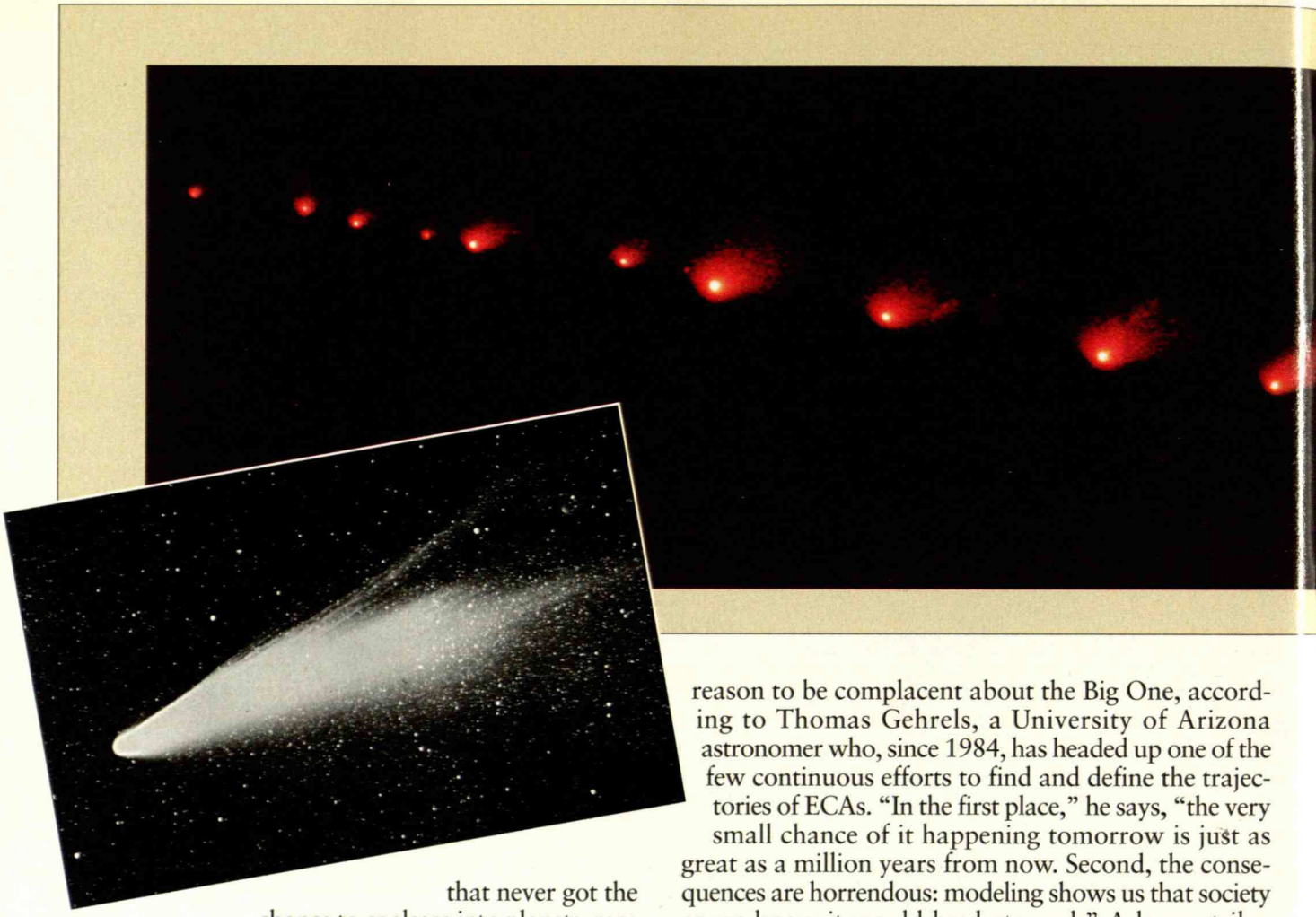
BY PETER TYSON

panic in dealing with an intruder from outer space. For the first time in earth's history, one of its species is capable of doing something about an approaching juggernaut, rather than simply taking it like a dinosaur. Ideas range from hitting an asteroid head-on with a mass of heavy metal to unfurling a "solar sail" that, over decades, could carry a threatening asteroid out of its earth-crossing orbit.

Not all of us needed the Jovian fireworks to remind us that the danger of an impact is more than just Hollywood fantasy. In the early 1990s, NASA convened a pair of workshops addressing the impact hazard—one on finding and another on destroying earth-crossing asteroids, or ECAs. The detection group, chaired by David Morrison of the NASA/Ames Research Center at Moffett Field, Calif., generated a report detailing the dimensions of the threat.

The earth lies at the center (to be terracentric about it) of a cosmic shooting gallery. Many millions of small worlds, remnants of the solar system's formation

ILLUSTRATION: LIZ MURPHY DESIGN



that never got the chance to coalesce into planets, race through space at velocities relative to the earth of up to 75 times the speed of sound. Some are slabs of rock, dirt, or metal (asteroids); some are sooty balls of ice only just held together by gravity (comets). Astronomers say the smallest asteroids, those less than 10 meters across, continually intersect earth, burning up harmlessly in the upper atmosphere. The heftier ones—some as big as a mountain range—come far less frequently. But they do come.

Our own planet would be pockmarked like the moon were it not for erosion, plate tectonics, and other geological forces that reshape the surface. Indeed, geologists have discovered more than 130 weathered impact craters—the largest a 200-kilometer-wide site at the northern end of the Yucatan Peninsula that marks the spot of the asteroid impact believed to have done in the dinosaurs 65 million years ago. Morrison and his colleagues estimate that an asteroid hits earth with the force of 2,500 Hiroshimas about once a millennium and, once every million years or so, with the equivalent of a million megatons of TNT, or 50 million Hiroshimas.

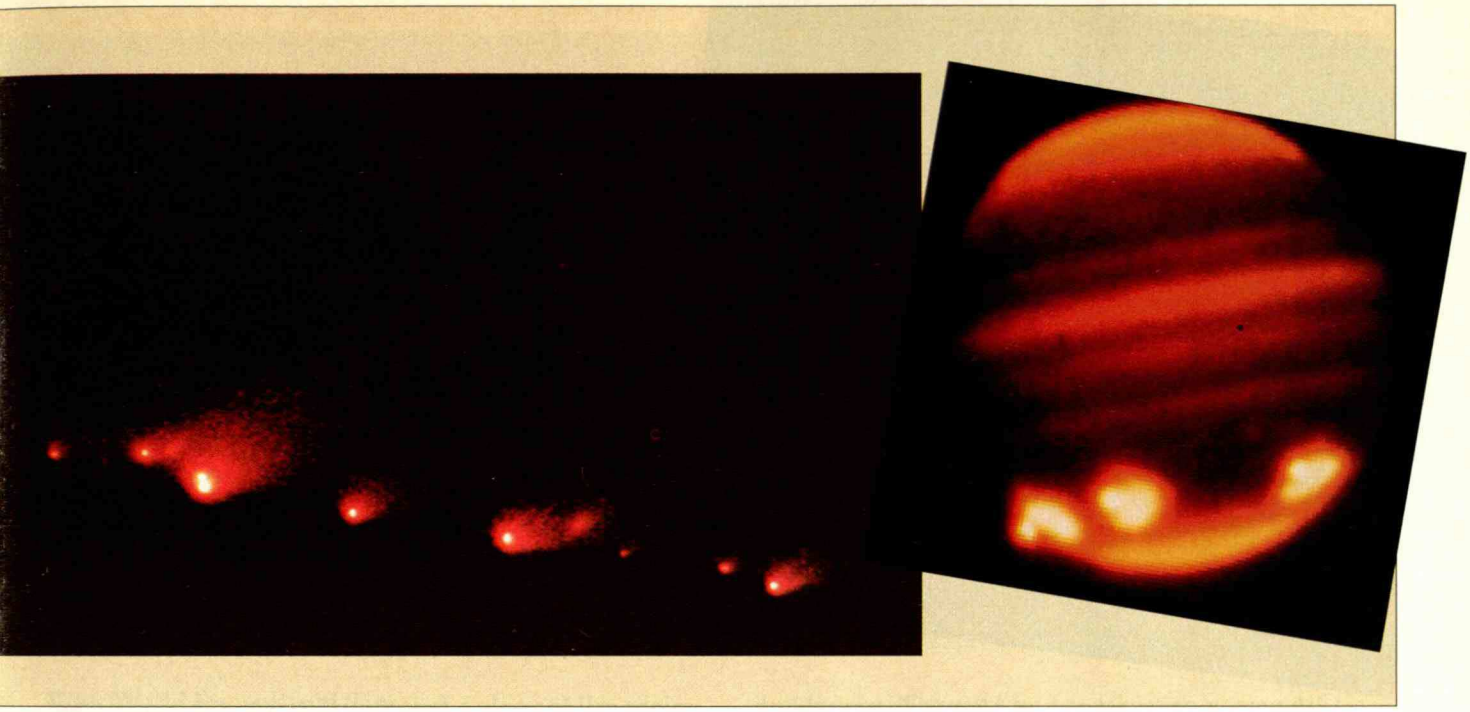
Even though a million years is a long time, there's no reason to be complacent about the Big One, according to Thomas Gehrels, a University of Arizona astronomer who, since 1984, has headed up one of the few continuous efforts to find and define the trajectories of ECAs. "In the first place," he says, "the very small chance of it happening tomorrow is just as great as a million years from now. Second, the consequences are horrendous: modeling shows us that society as we know it would be destroyed." A large strike, researchers say, would throw so much dust and ash into the stratosphere that a nonnuclear "winter" could wipe out one or more growing seasons, causing epidemic disease and starvation worldwide. "Instead of summer, fall, winter, spring," one physicist has remarked, "what you get is summer, fall, winter, winter, winter, winter, winter . . . "

Gehrels's effort, called Spacewatch, may soon have government-sponsored company. Given a wake-up call by Shoemaker-Levy 9, Congress last summer ordered NASA to appoint a committee to recommend how best to detect within a decade all ECAs bigger than one kilometer across. (One kilometer is believed to be the minimum size that would trigger the feared "winter.") Internationally, the asteroid threat is being taken no less seriously. Russia, Italy, and several other countries have recently hosted conferences on the hazard, and in April the United Nations will hold one of its own.

Nuke 'Em

What, then, could be done if astronomers suddenly announced that a mountain-sized asteroid or comet was on a collision course with earth? Any action, researchers agree, depends on three things—composition, lead time, and size.

PETER TYSON is managing editor of the environmental and science magazine Earthwatch *and a contributing writer for* Technology Review.



First, what is the object made of? Near-earth objects (NEOs), of which a tiny fraction may be earth-crossing objects, come in all shapes and sizes, but they are believed to comprise three basic types. Asteroids are either metal, as was the nickel-iron slab that carved the kilometer-wide Meteor Crater near Winslow, Ariz., or rock, like the supposed 80-meter chondritic (round-granuled) slab that exploded over the Tunguska region of Siberia in 1908, flattening trees across an area the size of the Los Angeles Basin. The third type is comets. The *Giotto* spacecraft, which flew through Comet Halley's tail in 1986, gave astronomers their first taste of what comets are now believed to contain: roughly a third each of ice, clay, and organic matter, including hydrocarbons in the form of an oil-like tar. Dealing with a heavy-metal asteroid presents different challenges from dealing with a loose agglomeration of matter such as a comet (a dirty snowball, as some astronomers call it).

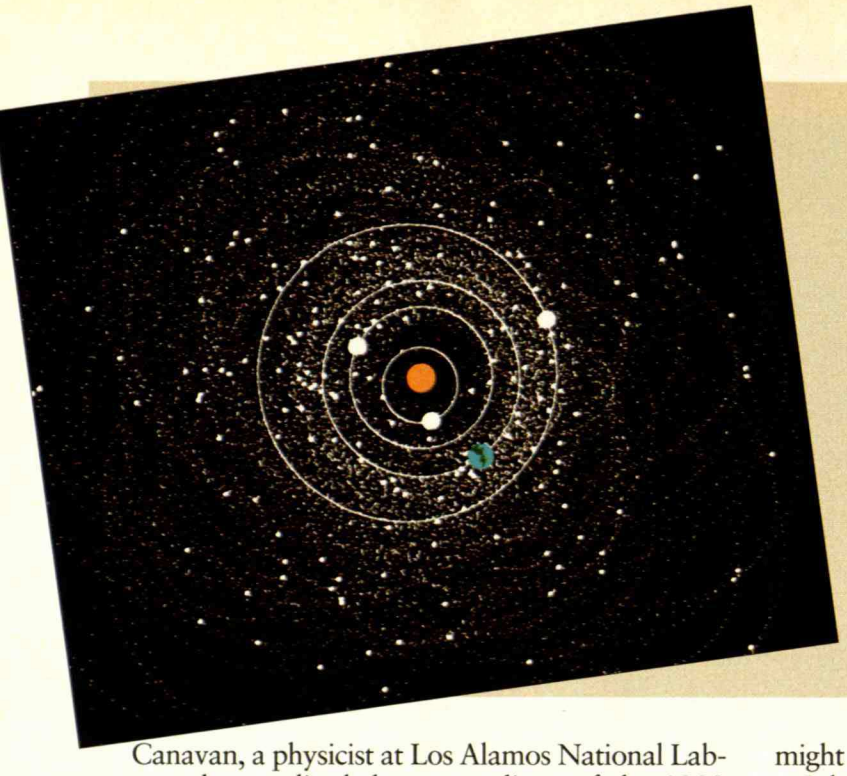
The amount of warning time is even more important than the object's composition. Astronomers say that if they were given the proper technology and funding, their chances of discovering earth-bound asteroids far enough in advance of an impact are very good. But comets pose a graver danger. While asteroids move at about 25 kilometers per second (roughly 50,000 m.p.h.), comets typically approach earth at more than twice that speed. A comet would strike with 10 times the energy of a comparably sized asteroid and give earthlings only half the time to intercept it in space. Perhaps most disturbing is the surprise factor of the so-called long-period comets. Because their orbits exceed 200 years, many of them have never been charted and can appear suddenly as if from nowhere. "We don't tend to detect long-period comets more than a year in advance," says Clark Chapman, an astronomer at the Planetary Science Institute in Tucson, Ariz.

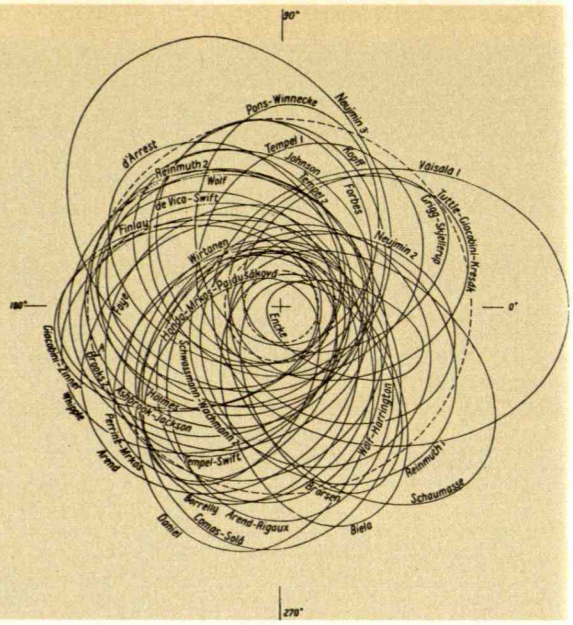
The third critical factor in any interception scenario is the intruder's size. Objects smaller than about 100 meters in diameter could be stopped by simply smashing something big into them: Boeing's Lightweight Exoatmospheric Projectile, an impactor device developed under the Strategic Defense Initiative, would work well, researchers say. But any object significantly larger—especially one beyond the "winter"-causing 1,000-meter diameter—would require draconian measures.

Physicists agree that the only way to generate enough energy to deal with a large object on short notice would be with a nuclear device. "A nuclear weapon has the highest energy per unit mass, and we're limited right now by the amount of mass we can put in space," says Gregory

A *comet's fragility can multiply the devastation of an impact. On its final approach to Jupiter last year, Shoemaker-Levy 9 resembled a string of lights more than the classic fiery plume exemplified by Comet Bennett (far left). That's because the comet's loose agglomeration of ice, clay, and hydrocarbons had broken apart under the pull of Jupiter's gravity when the comet passed by the planet two years earlier. Some scientists believe an earth-approaching comet should be treated with kid gloves to prevent it from fragmenting and setting off many separate cataclysms, as happened on Jupiter (above).*

PHOTOS: HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS; NASA





Canavan, a physicist at Los Alamos National Laboratory who coedited the proceedings of the 1992 NASA interception workshop. Either a U.S. Titan missile or a Proton, which the Russians routinely use to launch military payloads into low-earth orbit, could be used as a booster rocket, he says. To ensure that the object or objects were destroyed and not merely fragmented, with pieces still raining down on earth, Edward Teller, the developer of the hydrogen bomb, says simply that he would send up enough explosives to make sure the job was done right. "In other words," he says, "we are very sick, I have a cure, and my only concern is to achieve overkill."

If overkill did not succeed and large chunks still came at earth, researchers say the danger could actually be greater than if the original object were left alone. Recent studies show that a host of fair-sized pieces could have more devastating global consequences than a single "winter"-causing object, by igniting many separate conflagrations that merge into a global firestorm. For this reason, the Planetary Science Institute's Chapman says that if the lead time were very short, he would prefer to mount efforts to ride an impact out, such as evacuating the region expected to become ground zero and stockpiling food, rather than risk worldwide incineration.

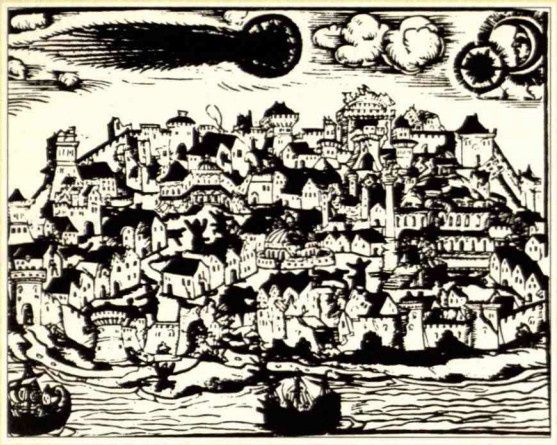
To avoid the dangers of fracturing an object, many researchers say the preferred method would be to nudge it slightly off course so that it bypasses earth, just as a hockey goalie deflects a speeding puck. The amount an ECA needs to be pushed out of a lethal orbit depends on the lead time: long-period comets first detected on the home stretch would need to be shoved sideways at speeds of a few meters to a few hundred meters per second to miss earth (velocities that, in the frictionless environment of space, would be maintained). ECAs with trajectories that can be calculated years or decades ahead of time—that is, billions of kilometers from impact—might call for only a few-centimeters-per-second nudge.

Johndale Solem, a mathematical physicist at Los Alamos whose papers on deflection scenarios could fill a fat three-ring binder, says the most efficient way to nudge an ECA is by detonating a neutron bomb—a device capable of producing a relatively gentle "blanket" of force instead of a violent explosion—or a series of such bombs. Solem's studies show that a so-called standoff burst, detonated about half of the ECA's radius above its surface, would offer optimal nudging with the least chance of splintering. While bringing two speeding bodies together with such pinpoint accuracy might seem daunting, Canavan, who chaired the interception workshop's session on homing technologies, believes it could be done with adaptations of existing "smart-bomb" devices.

Solem calculates that the most a standoff burst could move a kilometer-sized object without fragmenting it would be half a meter per second using a 4-megaton nuclear explosion. Given that the earth's radius is 6,370 kilometers, he notes, a rocket would have to hit the asteroid at least five months ahead of time for it to miss earth. With more lead time, less explosive power could be used. In a review article in *Nature* (December 3, 1992), Thomas Ahrens of Caltech and Alan Harris of the Jet Propulsion Laboratory in Pasadena, Calif., estimate that a 100-kiloton standoff burst would suffice to change the velocity—and hence the orbit—of a one-kilometer-wide object by one centimeter per second.

A series of one-two punches would further lessen the chance of fragmentation. "The first wave of bombs flashes, blisters the surface, and raises a great cloud of dust," says Anthony Zuppero, a physicist at the Idaho National Engineering Laboratory in Idaho Falls. "The second wave of bombs, milliseconds later, explodes and takes that dust cloud and blows it up and makes it push the object."

PHOTOS: COURTESY OF ANTHONY ZUPPERO/IDAHO NATIONAL ENGINEERING LAB; DIAGRAM: HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS



Charts showing the orbits of asteroids (far left) and major comets (second from left) reveal the solar system to be a complex and dangerous place. A close call with a comet sowed panic in Constantinople in 1556 (second from right), and Comet Wilson-Harrington passes near the earth every four years. Thousands of other large objects are also believed to have orbits that intersect that of the earth, making an eventual collision inevitable.

With World Enough and Time

Given sufficient advanced warning of a collision, scientists could test many of the proposed remedies with dry runs in space. Some of the groundwork has already been laid. The spacecraft *Clementine*, launched in January 1994 under the auspices of the Ballistic Missile Defense Organization (the new name for the Strategic Defense Initiative), successfully mapped the moon's surface using technology developed during Star Wars. *Clementine* failed before it could complete the second part of its mission—a flyby of the asteroid Geographos—but it proved that a relatively low-cost spacecraft ($80 million for the entire mission) could successfully rendezvous with an NEO—in this case, the moon. In 1996, NASA's Near-Earth Asteroid Rendezvous (NEAR) mission will attempt the first orbit of an NEO, 433 Eros, an irregularly shaped asteroid about 35 kilometers across.

The next step would be actual landings. While dramatically more expensive, soft landings by humans or robots could verify and fine-tune the information gleaned from a flyby, physicists say. Such data include an object's size, shape, volume, mass, gravity field, and spin state, as well as surface properties such as mineral composition and texture. But even hard landings could be informative. If an approaching spacecraft were to fire off a seismograph to the surface before crashing, says Canavan, the instrument could record the acoustic waves from the craft's impact and radio this information back to earth, allowing scientists to calculate the object's interior structure and strength.

If they had still more time on their hands—at least a century—to respond to an incoming ECA, some physicists cite a number of futuristic technologies that might be harnessed to help stop a doomsday asteroid or comet. "Spark guns," for example—such as those that Sandia National Laboratories developed for Star Wars—would be landed on the threatening object and would generate brief, intense electric sparks to send chunks of the ECA's own surface material into space many times a second, propelling the object in the opposite direction.

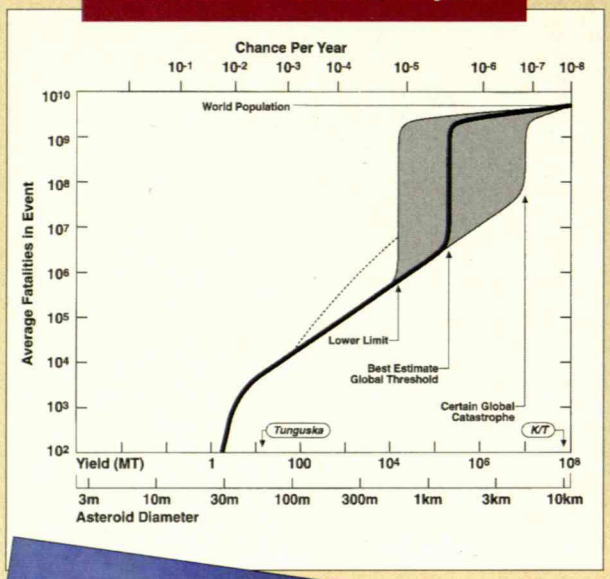
Anthony Zuppero, the Idaho physicist, proposes using a "steam rocket" to nudge a threatening object by pushing against it like a tugboat against a tanker. An on-board nuclear reactor would boil water and direct the steam out the rocket's nozzles. Since it would be impractical to launch enough water from earth, Zuppero proposes mining it from "nearby" comets. (Remember, these are futuristic scenarios.)

Perhaps the most elegant means proposed so far to nudge an ECA is "solar sails." The concept is simple: unfurl a giant reflector from the object's surface and let the radiation streaming out from the sun ease the asteroid into a new orbit. No nuclear devices required, only plenty of time.

While physicists delight in discussing such advanced interception concepts, all agree that the obvious solution today or even decades from now is nuclear. "If you have

ILLUSTRATIONS: JOHNDALE SOLEM/LOS ALAMOS NATIONAL LAB

The Risks of Asteroid Impact



The bigger the asteroid, the smaller the chance it will hit the earth (because there are fewer of them)—but the greater the megatonnage of the explosion and the higher the projected number of fatalities. The gray area on the chart represents uncertainty about the minimum size of an object that would set off a global winter. Whether the risks justify the cost of exploratory missions (such as the European Giotto *flyby of Comet Halley in 1986, which produced the revealing portrait shown here) is being hotly debated.*

a huge amount of time, you can talk about solar sails or putting engines on the thing," Solem says. "But when you get down to the question of what is cost-effective, a real hardheaded look always comes back with a nuclear device."

What Next?

Of course, no one seriously proposes rushing out to build a nuclear weapons system to counter asteroids and comets. Astronomers and physicists alike agree that thorough detection of ECAs is the first, essential step. In 1992, members of NASA's detection workshop proposed a Spaceguard Survey that would do just that. Named after a similar system in Arthur C. Clarke's 1973 science fiction novel *Rendezvous with Rama*, the Spaceguard Survey calls for half a dozen telescopes with 2.5-meter apertures (the minimum size needed to detect a kilometer-wide object at 200 million kilometers) to be set up around the world. The initial outlay would be $50 million, with $10 million a year in operating costs. Within 25 years, the astronomers asserted, they could detect 90 percent of all ECAs bigger than a kilometer across. The Shoemaker committee appointed by NASA last summer was expected at press time to propose something much like Spaceguard in its report to Congress this January.

A Congress-approved survey would add to those already under way. Since 1984, Gehrels's Spacewatch program has searched the skies continuously, using equipment that is less powerful than that proposed for Spaceguard—the University of Arizona's old 36-inch telescope. Spacewatch espies hundreds of objects each night, most in the asteroid belt; one in a thousand is an ECA. A radar astronomer, Steven Ostro of the Jet Propulsion Laboratory, also ranges and images NEOs with radars at the Goldstone tracking station in California's Mojave Desert and the Arecibo Observatory in Puerto Rico. The Air Force Space Command may soon add one or more of its array of GEODSS telescopes, currently used to track earth-orbiting satellites, to the search.

While the United States arguably lies at the forefront of this field, it has plenty of company. Canavan, the Los Alamos physicist, recalls visiting with astronomers in Russia in 1991 during the very week the Soviet Union fell apart. "They wanted to talk about asteroid defenses," he says. "It was kind of charming." All the nuclear nations and dozens of nonnuclear ones have sent representatives to various recent conferences on the hazard, and all have called for improved detection.

Astronomers and physicists also unanimously call for more theoretical work to gain a better understanding of NEOs and impact hazards. "We don't really know the composition or strength of these objects very well," notes Canavan. "How hard can you push on them, for example, before they break up into a bunch of frag-

DIAGRAM: CLARK CHAPMAN/PLANETARY SCIENCE INSTITUTE

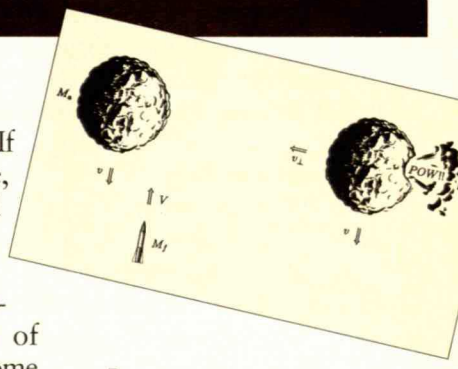
ments? That's precisely the kind of physics that needs to be measured during direct experiments in space."

Given the remoteness of the threat, some experts wonder whether actual space tests are worth the cost. Technological advances in coming decades, some scientists argue, may make obsolete any experiments today. Space tests would occur at the expense of other space research, not to mention more pressing earthly issues such as overpopulation and environmental degradation. Since space missions typically run about $200 million, the Planetary Science Institute's Chapman says, a single deflection experiment would be at least that and probably more. "At some point," he says, "you cross the line where, given the improbabilities of such a disaster, it's difficult to justify spending billions of dollars on it."

Canavan disagrees. He calculates that, even with the slim chances, the expected losses from the impact of a large ECA—say, two kilometers across—would amount to $400 million a year over the course of 1 million years. In a chapter for the forthcoming book *Hazards Due to Comets and Asteroids*, Canavan arrives at that figure by multiplying the world's total gross product of $20 trillion a year by the presumed 20 years it might take to get back to normal after such an impact, then dividing by the estimated frequency of such an impact (once every million years). Compared with the cost of a disaster, a few hundred million dollars devoted to experiments in space would be a drop in the bucket. And without such experiments, says Canavan, scientists may never learn how to nudge a comet or asteroid without fragmenting it.

Space missions would yield scientific spin-offs as well, proponents argue. NEOs have "more beauty than danger," says the University of Arizona's Gehrels, and through reconnaissance missions such as NEAR they can provide insights into the birth of the solar system. Astronomers believe near-earth asteroids in particular bear clues to the nature of the building blocks (known as "planetesimals") that formed the inner planets, including earth. Such missions could also set the stage for mining materials for use on earth, according to Zuppero. Certain NEOs are believed to contain industrially valuable metals such as platinum, palladium, iridium, and nickel, while other NEOs are thought to hold vast stores of hydrocarbons. "Something 16 kilometers across, like Comet Halley, has 1,000 OPEC-years of hydrocarbons," Zuppero says. For his part, Edward Teller feels the greatest spinoffs would be in creating research jobs and sowing international cooperation in dealing with a threat that concerns all humanity.

Indeed, some see thorough study, including experiments, as the moral obligation of our species. Notwithstanding our responsibility to protect other species on the planet, Solem says, our first concern is for *Homo sapiens*. "It's fairly conspicuous that if there is other intelligent life in the galaxy, it's not talking to us very loudly," he says. "If intelligence is that rare, then it's precious and there's a strong cosmic need to maintain it."



Johndale Solem, a physicist at Los Alamos National Laboratory, proposes deflecting an earth-bound asteroid with a neutron bomb, which he believes would exert a blanket of force without fracturing the object. Caught early enough, the object would need to be nudged sideways, whether by a detonation on its surface or in space nearby, only a few centimeters per second.

While few would dispute the importance of protecting ourselves, some feel the costs of reducing the impact risk must be weighed against other potential global disasters. Asteroids represent a hazard like any number of other perils that confront civilization, says the Jet Propulsion Laboratory's Ostro, and we must be "strategically intelligent" in reducing risks from all sources. In a recent article in *Issues in Science and Technology* he coauthored with Carl Sagan, Ostro offers examples of other low-probability but potentially catastrophic risks, including the rise of drug-resistant lethal organisms or the chance that AIDS, through a mutation or transgenic exchange, could become as infectious as the common cold. Ostro and Sagan note that even annual deaths from cigarette smoking or diarrhea—millions each worldwide—arguably deserve more of our attention than potential

PHOTOS: ANTHONY ZUPPERO/ IDAHO NATIONAL ENGINEERING LAB

cosmic impacts. "A critic might contend," they write, "that with limited global resources, the human species would benefit much more from global anti-smoking and oral-rehydration campaigns."

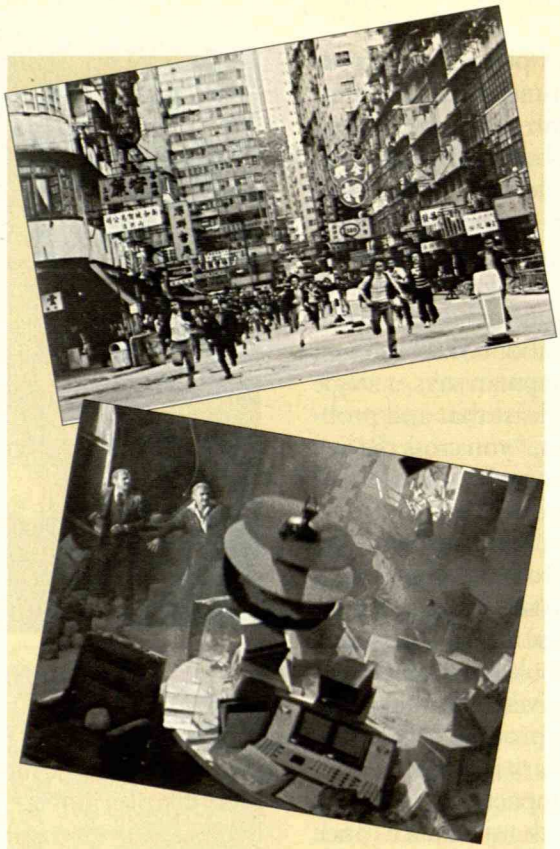
Weighing the economic cost of testing nuclear charges in space is one thing; weighing the political cost is quite another. For starters, two agreements—the 1963 Limited Test Ban Treaty and the 1967 Outer Space Treaty—forbid the use of nuclear weapons in space. Even if authorities deemed the threat serious enough to relax the rules, harnessing nuclear explosives as instruments of salvation, even on a trial basis, might be a hard sell to a public still reeling from decades of nuclear anxiety.

Costs, both economic and political, arguably would be an order of magnitude or two higher if the next logical step were taken—namely, developing and deploying actual defensive systems. In their *Issues* article, Ostro and Sagan argue strongly against preparing any such system now. The threat, in their minds, is too remote to justify the costs, much less the danger that such a system could fall into the hands of a Hitler or a Stalin. The two astronomers also suggest that if researchers can devise ways to divert a threatening asteroid away from earth, then at some point over the next few hundred thousand years they may also be able to divert an otherwise harmless asteroid into earth.

Most researchers in the field agree that developing a defensive system before the full dimensions of the threat are known would be premature. Solem proposes a graduated approach to dealing with the hazard. Get Spaceguard under way, continue theoretical studies, perhaps undertake an experiment or two in space to learn more about NEOs. At least a decade of such work will be required, Solem estimates, before results indicate whether we should build a defensive system.

If the benefits were deemed to outweigh the risks, what would such a system look like? Solem imagines half a dozen unarmed boosters under the control of the United Nations. The boosters could be modified Titan IVs—"we seem to have more of them than anything else," he notes—or even something smaller. (The Spartan missile, for example, was designed to carry a four-megaton warhead, the same size needed to deflect a one-kilometer object five months ahead of time.) In Solem's hypothetical system, the nuclear payload would be held separately by a consortium of nuclear nations. When and if a threat developed, the boosters could be married with the explosives, transported to a launch pad, and dispatched. The cost to maintain such a system would run about $100 million a year, Solem figures. "That's reasonably conservative but also reasonably reasonable," he says. "If it was decided that you would need to be able to pull something together in a week," he adds, "then you'd have to have the boosters on standby status."

Which, ironically, puts it just in the range of the response depicted in the movie *Meteor*. Though as Hollywood as they come, the film was actually inspired by a 1967 engineering class at MIT in which students, presented with a hypothetical asteroid strike, came up with a nuclear missile–based solution. In fact, while *Meteor* may have seemed to viewers little more than science fiction when it appeared, 16 years later it seems remarkably prescient. Last July's fusillade of fragments on Jupiter echoed those depicted in the film. The movie's overnight thaw of Cold War animosities—embodied in actor Brian Keith's too-quick-to-grin Soviet physicist Dubov—surely must have rung false with 1979 viewers, but in today's post-glasnost climate, it seems quite plausible. Finally, NASA's nuclear solution in the film, in which the joint Russian-American rocket force successfully pulverizes the incoming asteroid, is precisely the one we would use now under similar conditions, though perhaps minus the thrilling crescendo of martial music.■



Beneath the Hollywood sensationalism, the 1979 disaster flick Meteor ***managed to get some key elements of an impending impact right—that it would be preceded by a number of small fragments, for example.***

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PHOTOS: THE KOBAL COLLECTION

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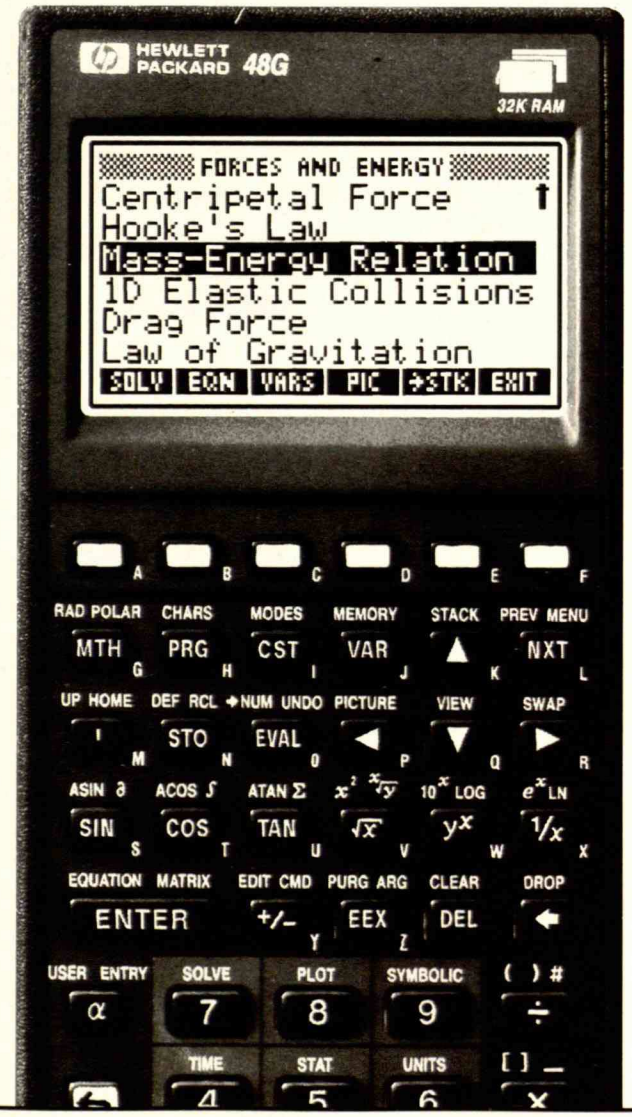

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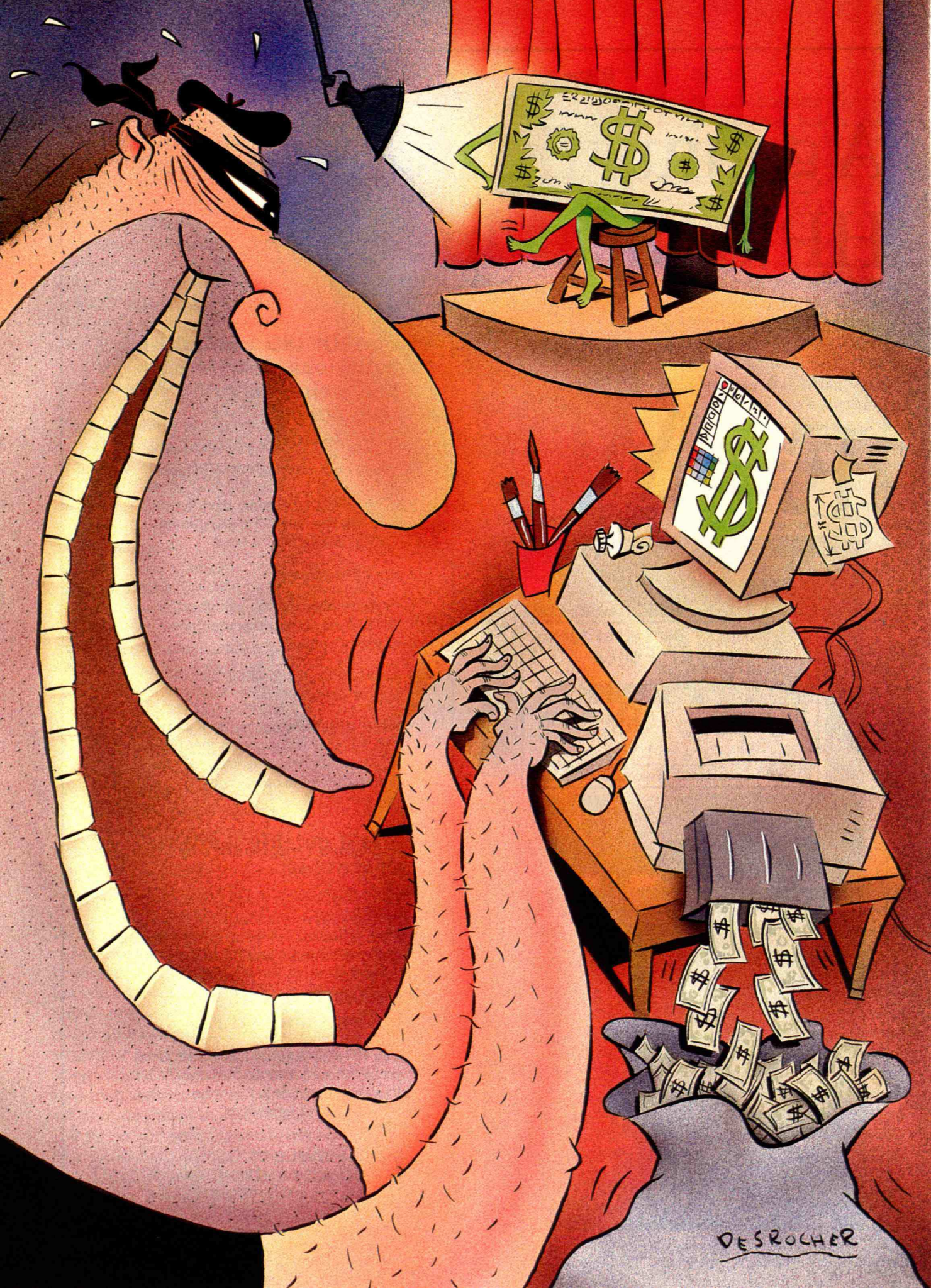

DESROCHER

Desktop Counterfeiting

❖ BY DOUG MCCLELLAN ❖

In 1989, members of an international counterfeiting ring swindled three-quarters of a million dollars from First Interstate Bancorp of Los Angeles, one of the nation's largest banks, with a single counterfeit check. After stealing a legitimate corporate dividend check issued on a First Interstate account, the counterfeiters scanned an image of the check, including the authorized signature, into a computer, electronically altered the amount and the name of the payee, and printed the fake with a laser printer. The result was good enough to pass unnoticed through First Interstate's clearinghouse, where checks are authorized for payment. When the check cleared, the thieves whisked the money overseas with a wire transfer and disappeared before the bank or the corporation issuing the check uncovered the fraud. ❖ In 1992, a New York woman was accused of impersonating a military officer and fleecing a series of banks, jewelers, and exclusive shops of more than a half-million dollars with counterfeit checks. She used laser printers and embossing machines to forge identification cards, fake letters of credit, and the checks. When she was caught and incarcerated, her accomplice bailed her out of Rikers

VIRTUALLY ANYTHING THAT CAN BE PRINTED ON PAPER—WHETHER A BIRTH CERTIFICATE OR A BANKNOTE—CAN BE FORGED BY ANYONE WITH EVEN A RUDIMENTARY DESKTOP-PUBLISHING SYSTEM. WILL NEW DETERRENTS PREVENT SUCH FRAUD FROM REACHING EPIDEMIC PROPORTIONS?

ILLUSTRATION BY
JACK DESROCHER

Island prison with a certified check for $30,000—which was also a fake.

In 1993, Ahmed Abdullah al-Ashmouny, an Egyptian citizen, was indicted for counterfeiting thousands of visas on a color copier and selling them to other Egyptians, including followers of accused terrorist leader Sheik Omar Abdel Rahman of Jersey City, enabling them to illegally enter the United States. According to Andrew Laney of the U.S. Department of State, the fakes were almost indistinguishable from actual visas.

Such incidents are just a few reminders of what has become America's fastest-growing means of fraud: desktop counterfeiting. Using low-cost personal-computer-based publishing systems, counterfeiters have forged virtually every kind of paper document or certificate, including checks, banknotes, passports, Social Security cards, birth certificates, stock and bond certificates, automobile titles, bus and rail passes, food stamps, even grocery store coupons from the Sunday newspapers.

Of these, checks and currency are perhaps most vulnerable. An American Bankers Association survey found that banks reported more than 1 million cases of fraud and lost $813 million from counterfeit checks in 1993, a 43.5 percent increase from the $568 million in losses reported in 1991. While the majority of cases involve such time-honored techniques as writing checks on nonexistent funds, the banking association contends that a significant and rapidly growing percentage is due to desktop counterfeiting. Similarly, the U.S. Secret Service, which is charged with protecting American currency, estimates that computer-aided banknote forgery could balloon from today's modest levels into a $2-billion-per-year economic sinkhole by decade's end. The National Research Council, the research arm of the National Academy of Sciences, concurs. A report issued by the NRC's Committee on Next-Generation Currency Design called desktop counterfeiting the biggest threat facing U.S. currency today.

Counterfeiting was once the domain of skilled crooks who needed expensive engraving and printing equipment. But as the prices of desktop-publishing systems have dropped, counterfeiting has gone mainstream. Personal computers with the graphics needed for counterfeiting are now available for a few hundred dollars. While in 1989 an Apple laser printer that reproduced 300 dots per inch (dpi) cost $3,900, today such printers sell for less than $500, and printers delivering 600 dpi, the current standard, cost well under $1,000. A counterfeiter can purchase a color ink-jet printer—the fastest-growing tool of choice for desktop counterfeiting—for less than $500. By 1995, an estimated 4.9 million color printers will be in use with personal computers in the United States, with another 4 million overseas.

DOUG MCCLELLAN reports on science and technology for the Albuquerque Journal *and is the owner of a desktop publishing firm in Santa Fe, N.M.*

Similarly, five years ago a color scanner capable of reproducing 600 dots per inch would have set a forger back $10,000; now they too cost less than $500.

Counterfeiting has flourished for as long as there has been something worth forging. China, which invented paper money in the tenth century, once carried the grim warning on its currency that whoever forged or circulated counterfeit notes would be beheaded. England treated counterfeiting as a hanging offense, as some 600 unlucky forgers discovered before the law was repealed in 1832. Dante, in *The Inferno*, had such a poor opinion of counterfeiters that he placed them in one of the lowest circles of hell. And the Roman Catholic Church now includes check fraud and forgery as sins in its new catechism.

Today's counterfeiters have little reason to worry about prison, much less hell, since desktop forgery is a crime that often goes unprosecuted. Unlike traditional counterfeiters who leave a lot of tracks because of the specialized lithographic printing equipment they require and the quantities of forgeries they produce, desktop counterfeiters are much harder to catch because the systems they use are ubiquitous and the number of forgeries they produce are typically small. Moreover, prosecutors feel they must place more of a priority, and limited funds, on crimes of violence rather than fraud. Consequently, according to the FBI, banks currently recover only about 13 percent of their losses from check fraud. And some enforcement officials simply give up. Gregory Litster, senior vice-president at Imperial Bank in Los Angeles, points out that several southern California prosecutors have disbanded their check-fraud offices because of budget restrictions.

Banks, corporations, and the U.S. Treasury are therefore realizing that the best way to stop counterfeiting is to prevent it from happening in the first place, and as a result they have begun to undertake aggressive counterfeit-proofing measures.

Deterring Check Fraud

Checks are perhaps the most lucrative target for the desktop counterfeiter, given that billions of them circulate every year through the U.S. banking system and that they are easily forged. "What is dumbfounding to me is that if you took every bank robbery that occurred in the United States in 1992—every bank, every savings and loan, every credit union—there were $63 million in losses. But in the same year, those same financial institutions lost $4.2 billion in fraud," says Frank Abagnale, a former counterfeiter and con artist who now advises financial institutions on avoiding check fraud. "The person who steals money with a pen steals far more money than the person who steals with a gun.

"When you went out 25 years ago to forge a check issued by a corporation, the first thing you needed was a four-color press that cost a quarter of a million dollars,

used," Abagnale says. You also needed a great deal of skill to operate the press and a great deal of patience, since it took several months to create a plate, he says. "Now, using just a personal computer, scanner, and printer, you can sit in a hotel room and produce a check from any major company."

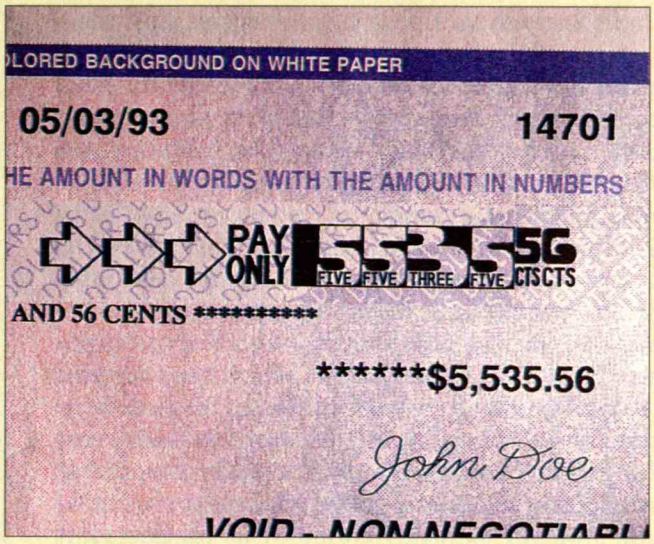
For five years until he was 21, Abagnale pulled off a series of audacious scams, passing himself off as a pilot, pediatrician, college professor, assistant attorney general, and stockbroker and cashing $2.5 million in fraudulent checks throughout Europe and all 50 states. After serving many years in French, Swedish, and U.S. prisons, he decided to use his talents to help corporations thwart white-collar crime.

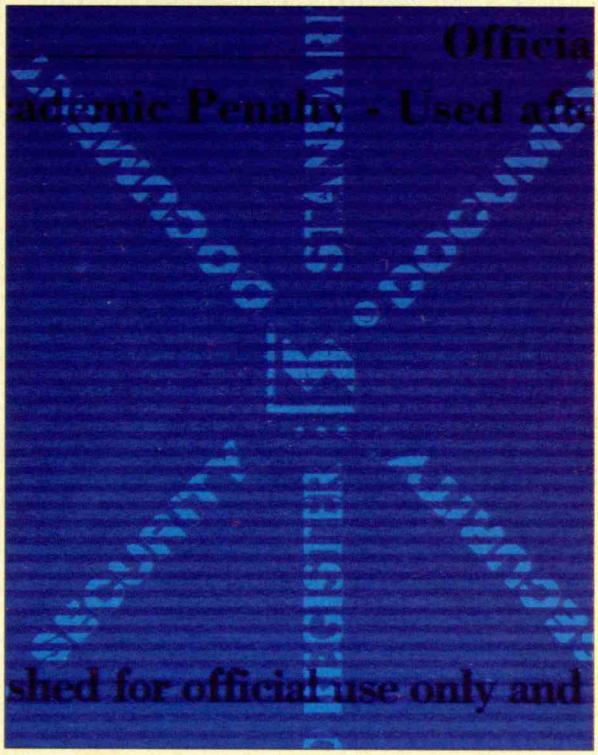
Abagnale outlines the ease with which a forger can create fake corporate checks. By stealing or "borrowing" a company's payroll, dividend, or refund check, the counterfeiter can quickly scan the check, with corporate information and signatures, into a computer. Using one of many popular desktop-publishing programs, the forger can then change the amounts and payee name on the check. When the fraudulent check is ready to print, the counterfeiter can stop at an office supply store and buy the basic materials for a corporate check, such as "safety" check paper and magnetic laser-printer toner used to print the routing numbers at the bottom of checks. (The routing code is one of those mysterious numbers on the bottom of a check that identifies the originating bank. The numbers are printed in magnetic ink so they can be sorted automatically.)

Even without a master check, Abagnale says, a counterfeiter still can use a scanner to make a passable forgery by duplicating a corporate logo from a brochure or newspaper advertisement. Desktop-publishing programs allow the forger to resize the logo to any shape and repeat a small, shaded imprint of it across the background of the check, a common design.

How can the forger fake the signature for the check? Easy, Abagnale says. Simply get a copy of the company's annual report, which usually includes signatures of all top officers, and scan those signatures into the computer.

Abagnale says a crafty counterfeiter also knows how to use time. Banks are required by law to pay local checks within two working days and out-of-town checks within five days, changes mandated by Congress in 1987 to the dismay of the banking industry. So, Abagnale explains, a forger counterfeiting a check from a major company in Boston might print the routing code for, say, the Federal Reserve branch in Honolulu. The





To foil high-tech counterfeiters, banks are designing checks that incorporate a host of new deterrents. Some checks (top) print dollar amounts in special fonts that are hard to modify and add warning banners that describe the color or special characteristics of the check. Other versions include fluorescent ink (bottom) that will appear only under ultraviolet light.

PHOTOS: STANDARD REGISTER

"mistake," which will pass by all but the most alert teller at one of the Boston bank's branches, will automatically send the check to Hawaii. Before the misrouted check is returned to the Boston bank on whose funds the check was drawn, the receiving branch will have had to honor the check, and the forger will have disappeared with the money.

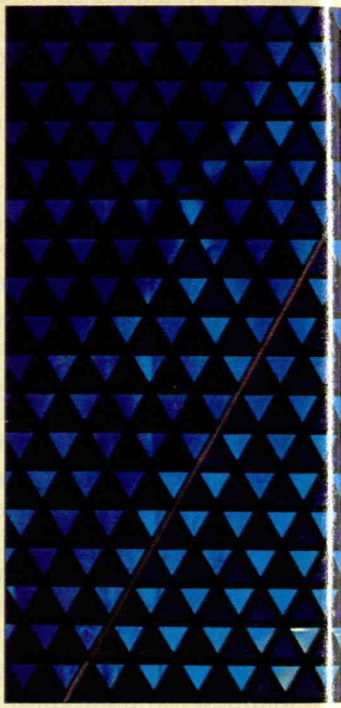
Traditionally, the defrauded bank has shouldered the loss from a scam like this. But recent changes in the Uniform Commercial Code, the law governing commercial transactions, have placed more of the burden on corporations. These 1990 revisions, which have been adopted by a majority of states, allocate losses according to respective degree of negligence. It's the same theory that has long been used in product liability cases. For instance, under the law, a widget manufacturer could be held liable for damages caused by its products if it neglected to use a safety device that was available on the market. The effect of the changes, bankers say, is that companies now have more responsibility for using anti-counterfeiting devices, and banks now have a means to persuade their corporate customers to adopt more secure checks.

Imperial Bank of Los Angeles, California's tenth-largest bank, recently began marketing checks with several counterfeit-deterrence features. Imperial attracts as customers many title and escrow companies, which are enticing targets for counterfeiters because their checks are typically for large amounts. One deterrent in the new checks, sold under the name SafeChecks, uses halftones, the groups of thousands of small dots commonly used to print photographs in newspapers and magazines. When viewed at reading distance, the dots blend together into a continuous image. While the dots are typically one size, halftones can also be composed of big dots interspersed with little ones. If the little dots are small enough, they fall below the resolution threshold of most copiers and scanners and cannot be accurately reproduced. Designers can use this feature to make patterns that will spell out the word VOID on copies that do not appear on the original.

The check paper also includes a watermark, an image formed by varying the thickness of the paper during its manufacture. These images become part of the paper and are difficult to reproduce, because they cannot be seen with reflective light—the kind used by scanners and copiers to make reproductions. The check will feature a warning banner that tells the recipient to look for the watermark. They will also include some fluorescent ink that will appear only under ultraviolet light.

The counterfeiter who attempts to modify a legitimate SafeCheck will run into other problems. A special chemical coating on the paper reacts to ink eradicators, so any attempt to change the payee or dollar amount brings out the word VOID in three languages. Imperial's Gregory Litster says check fraud losses have been cut by 90 percent since the bank introduced SafeChecks in 1993.

One technique for making currency counterfeit-proof entails embedding tiny bits of iridescent plastic film in the paper. Under special lights, these so-called planchettes appear like splashes of rainbow-colored confetti.

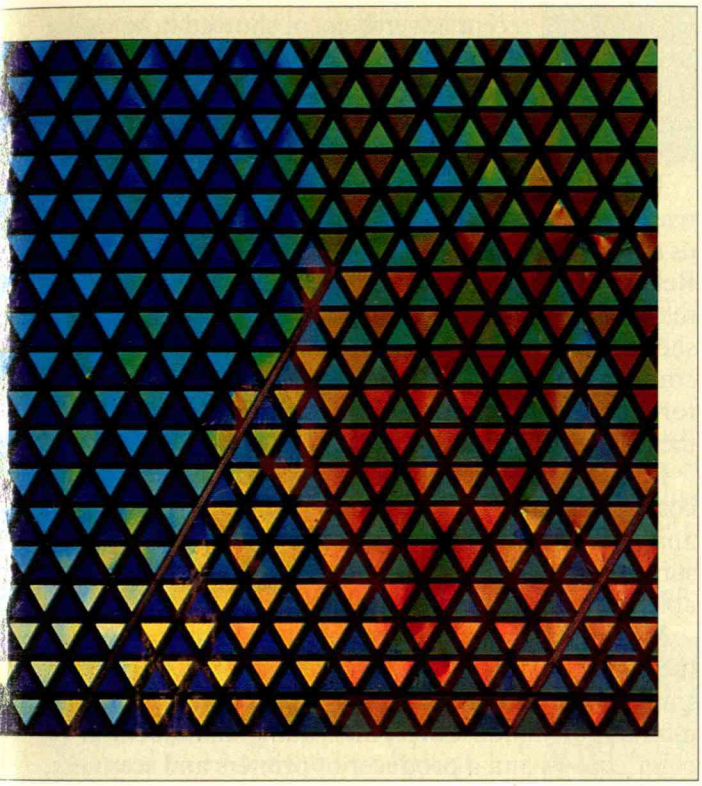


Like many other banks, Imperial offers its corporate customers another form of protection known as Positive Pay, under which the corporation notifies the bank, either electronically or in writing, of all checks it has issued, including serial numbers and amounts. The bank then compares checks presented for payment against the list and rejects those that do not match.

Check clearinghouses are also adopting new techniques to identify bad checks more quickly, according to the American Bankers Association. Some receiving banks scan the image of a check, or at least the information encoded in a check's magnetic ink, and electronically transmit that information to the bank at which the check originated. This process enables the originating bank to quickly verify a check by phone rather than waiting for the checks to be transferred by mail.

Safeguarding Currency

While banks and corporations fret over counterfeit checks, the U.S. government has a bigger concern: its money. The greenback, the world's most popular currency, is also its most counterfeited. "The reason the dollar is counterfeited so often is because it is so universally accepted; it is considered the world's currency," says Thomas Ferguson, deputy director of research and development for the Federal Bureau of Investigation. The amount of counterfeit currency is significant, though not huge as a percentage of the more than $9 billion in banknotes produced each year by the U.S.



Bureau of Engraving and Printing and the nearly $300 billion per year that are processed through the Federal Reserve system. According to Secret Service statistics, $19.6 million in counterfeit notes made their way into the commercial money stream during fiscal year 1993. Agents seized another $24.2 million before it could be circulated, and detected another $120.8 million in counterfeit U.S. notes overseas.

About 90 percent of counterfeits are produced the old-fashioned way, by skilled printers who use engraved plates and sophisticated lithographic printing equipment. These counterfeiters are relatively easy to catch. But the Secret Service is most worried about the other 10 percent produced by desktop counterfeiting, a segment that is doubling every year. Faced with this prospect, the Bureau of Engraving and Printing realized it had to act, and this summer announced plans for the first major redesign of U.S. currency since 1929. Beginning in 1996, the new design will appear in a new denomination every year, starting with the $100 bill, says Ferguson.

To determine appropriate modifications, the bureau not only did its own research but sought help from the National Academy of Sciences, which convened the Committee on Next-Generation Currency Design. The new banknotes, drawn from the recommendations of both groups, will incorporate a host of new deterrents.

The change most users will notice are in the portraits. The subjects won't change—Benjamin Franklin will still grace the $100 bill, Alexander Hamilton the $10, and so on. But their portraits will be larger, although still done in classic banknote style, and accompanied by additional portraits of the statesmen done in watermarks, which cannot be reproduced in a copy. (The watermark, a centuries-old technique invented in Italy, will actually be making its second appearance in U.S. currency. The first was during the Civil War, when an estimated one-third of all paper money in circulation was fake. The counterfeiting epidemic of the 1860s led President Lincoln to create the Secret Service, whose original charge was to track down counterfeiters. Congress later standardized the host of local banknotes by instituting a single national currency incorporating watermarks, but these were dropped in 1879 when the Treasury deemed that a new kind of linen paper that used bands of colored threads provided a sufficient safeguard.)

Other anti-counterfeiting measures planned for the new currency are of more recent vintage. A small section of each banknote will incorporate what is known as "color-shifting," or optically variable, ink. Such inks, already used in denominations of the deutsche mark, the lira, and the Belgian franc, change color depending on the angle at which they are viewed. For example, one kind of color-shifting ink looks green when viewed from the top and black when seen from a 45-degree angle. Because scanners and color copiers can reproduce only one of the colors, fakes will be easier to spot. Moreover, because these inks are expensive and difficult to manufacture, they are beyond the reach of most counterfeiters, according to the next-generation currency committee.

As another line of defense, planchettes—colored or reflective bits of paper or plastic a few millimeters in diameter—will be randomly embedded in the paper, the FBI's Ferguson says. Looking like tiny bits of iridescent confetti, planchettes give off distinctive colors when viewed with special lights. The planchettes will join the red and blue silk fibers that paper money has incorporated since 1929. These threads have lost some of their deterrence because counterfeiters can simulate their look simply by making a good-quality color copy.

The printing on U.S. banknotes also will be enhanced with designs that use the limits on reproduction resolution to play optical tricks. Ferguson says the new notes will use moire patterns, which are intricate designs of fine lines. When they are reproduced in a scanner or copier, the lines become distorted, looking like ripples in a pond of water. That is because copiers and scanners do not have a sufficiently fine resolution to reproduce the patterns accurately. Paper currency will also incorporate the variable-dot pattern used in checks and other documents that, while undetectable on the original, causes copiers to spell out the word VOID on any copies.

The Treasury will continue to print currency using the high-pressure printing process known as intaglio, in which printed lines are slightly raised, or embossed. The effect, which cannot be duplicated by offset presses,

PHOTO: CRANE BANKNOTE PAPERS INTERNATIONAL

Watermarks such as this portrait of Andrew Jackson will be incorporated as anti-counterfeiting measures in the next generation of U.S. paper money. Such images, formed by varying the thickness of the paper during its manufacture, are difficult to reproduce because they cannot be seen with the reflective light used by scanners and copiers.

copiers, laser printers, or other nonimpact printing processes, imparts a distinctive feel to the banknote. No other piece of paper feels quite like a dollar bill.

The Treasury will also modify two deterrents introduced in 1991. One is the "security thread," a polyester strip 1.4 to 1.8 millimeters wide imprinted with metal characters. Invisible under normal, or reflected, light, the thread cannot be copied but is easily seen when a bright light shines through the paper. The thread is now placed in the same location in all denominations through the $10 bill. In the new bills, different denominations will use the thread in different places.

In addition, the new currency will modify the 1991 deterrent known as microprinting. Microprinting produces words seven-thousandths of an inch high that look like a solid line from a short distance. On the $100 bill, for example, the oval line that borders Benjamin Franklin's portrait is actually the microprinted words "THE UNITED STATES OF AMERICA" repeated several times. A sharp-eyed store clerk who knows what to look for can tell if the microprinting is present.

Ferguson says the microprinting will be enhanced in the new bills—though he declined to elaborate—because inexpensive scanners and printers are now advanced enough to reproduce the existing microprinting. In fact, a recent advertisement showed how well a $1,799 color scanner made by Envisions Co. could reproduce the microprinting on a $100 bill. "No other scanner can scan a hundred bucks and capture the hidden detail as well as ours," the ad proclaimed.

The ad caught the attention of more than prospective customers. "The Secret Service visited us and asked us not to use paper currency in our ads anymore," says Rebecca Sanders, director of business development at the company. "You won't see that anymore." Ironically, she adds, Envisions itself has been a target of desktop counterfeiters; some mail-order customers have paid for scanners with counterfeit cashier's checks, causing the firm to change its policy on COD shipments.

Ferguson says the new design will add a penny to the cost of printing U.S. banknotes, from 3.8 to 4.8 cents apiece. Every cent adds about $90 million to the Treasury's annual printing bill—a price he considers reasonable given the magnitude of the threat.

Meanwhile, would-be counterfeiters may also find themselves stymied by security devices that appear on some of the equipment used to print fakes. For more than a year Canon Corp., the leading manufacturer of color copiers and a producer of printers and scanners, has quietly incorporated two anti-counterfeiting features into its business products, says David Farr, senior vice-president and general manager of Canon USA, Inc. The copiers include a specially programmed microchip that recognizes the currencies of several countries, including the United States and Japan. If someone attempts to copy the currency, the copier will print a black sheet of paper instead.

A more subtle deterrent imprints a code of the machine's serial number on every copy it produces. The number is encoded in "microdots" that can be printed anywhere on the page. "Nobody even knows these features are in there," Farr says. The serial number can be decoded only with special equipment that he declined to identify, which the company provides to the Secret Service and other federal agencies solely for tracing counterfeits to the copier on which they were made.

Others Get into the Act

The U.S. Treasury is not the only federal agency that has had to grapple with the threat of desktop counterfeiting. A new U.S. postal money order, introduced in 1991 and modified since, has dramatically reduced alterations and counterfeiting.

The Post Office sells about 200 million money orders a year, which are almost as widely accepted as cash. The new money order incorporates some of the security features planned for U.S. currency. It is printed in multiple colors that merge from yellow to green to purple and back to yellow. Fine lines, also in different colors, run across the face of the document. A deep, richly

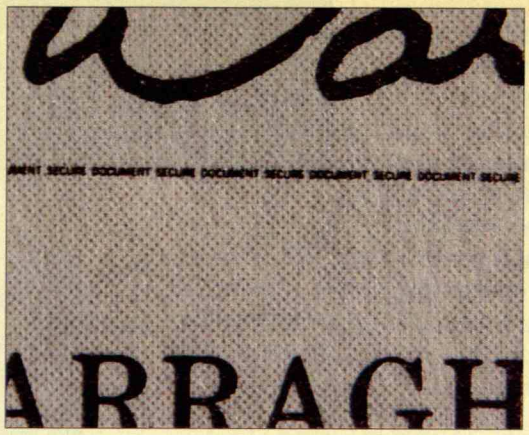
PHOTO: CRANE BANKNOTE INTERNATIONAL

detailed watermark of Benjamin Franklin, the nation's first postmaster, fills a large oval on the paper. Embedded within the paper is a security thread and special fibers that glow under ultraviolet light. Richard W. French, a senior forensic analyst with the U.S. Postal Service who designed the money order, says it has several other counterfeit-deterrent features, such as tamper-resistant inks, that he does not want to discuss in detail.

Because of such measures, counterfeiting of postal money orders has dropped by some 60 percent in two years, while alterations of legitimate money orders have also plunged, says Shaun O'Hara, national program manager for the Post Office's Office of Criminal Investigation. In fiscal 1993, the Post Office caught 397 counterfeits, but the number dropped to 14 for the first half of the 1994 fiscal year, O'Hara said. Alterations for the first half of 1994 were 499, compared with 1,589 for the same period in 1993.

The U.S. State Department is also getting into the act by introducing a new type of non-immigrant visa, distributed by U.S. embassies and consulates around the world to temporary U.S. visitors. The new visas use digitized photographs that are produced and stored on a computer and printed directly on the paper. Visas have typically used passport photographs, which were simply glued onto the page and easily removed and replaced with a different photograph by a skilled forger. Digitized photos are also used on driver's licenses in some states to help protect against fraud.

Gary Shaeffer of the Bureau of Consular Affairs says the new visas also incorporate raised intaglio printing that can be verified by a passport officer with a brush of the fingertips, while intricate background designs thwart most attempts to scan or copy the document. About 40 percent of the estimated 5.5 million non-immigrant visas issued in 1994 were the new kind.



The U.S. Treasury plans to enhance microprinting on new bills because today's desktop scanners can easily reproduce type as tiny as seven-thousandths of an inch high.

The State Department is also planning to issue new passports that contain several anti-counterfeiting features, including a security thread, watermarks, security stains in the paper that turn blue when exposed to ink eradicators, fluorescent ink, and iridescent planchettes, according to Shaeffer.

State and local documents are also vulnerable, according to Gideon Epstein, chief forensic document analyst with the Immigration and Naturalization Service. Underlying the problem is a lack of standards. For example, more than 7,000 types of U.S. birth certificates are issued in this country by authorized governments and hospitals, he says. "If everybody could agree to use the same security paper, forgers would be less able to pass off documents on different types of papers."

Finally, even manufacturers of those ubiquitous store coupons are adopting anti-counterfeiting technologies. Forging $1 laundry-detergent coupons may not sound like a big deal, but coupon fraud could add up to hundreds of millions of dollars a year. U.S. companies annually print 320 billion coupons, of which a little more than 2 percent, or some 7 billion, are redeemed for a value of about $4.5 billion, according to Richard Krautsack, president of Comark Merchandising, Inc., a coupon printer. He estimates that as many as 15 to 20 percent of coupons redeemed are fraudulent. If he is right, that means the number of fraudulent coupons redeemed is nearly $1 billion a year. Comark sells a patented variable-dot system known as Copy-Stop that, like others, spells out the word VOID when someone attempts to copy a coupon.

No document is safe anymore, now that counterfeits are so easy to make with basic computer know-how. That's why the U.S. Treasury isn't going to wait another 60 years before it next overhauls American currency. And that's why those who seek to stop counterfeiting are trying to dream up ever more complicated and esoteric deterrents—the more the better.

"You want to have more than one feature," says Glenn Sincerbox, an IBM researcher who chaired the Committee on Next-Generation Currency Design, "to outwit those who are always trying to take counterfeiting a step further." In an age of global computer networks, he has few illusions about the threat posed by failing to do so. "Imagine if someone distributed a bitmap of a $50 bill over the Internet," he says. "Everybody and his uncle would be printing money."■

To view this article with interactive links, visit our World-Wide-Web server at <http://web.mit.edu/afs/athena/org/t/techreview/www/tr.html>.

PHOTO: STANDARD REGISTER

MITnews
FROM THE ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT FEB/MAR 1995

System Dynamics for Kids

By Jim Hight

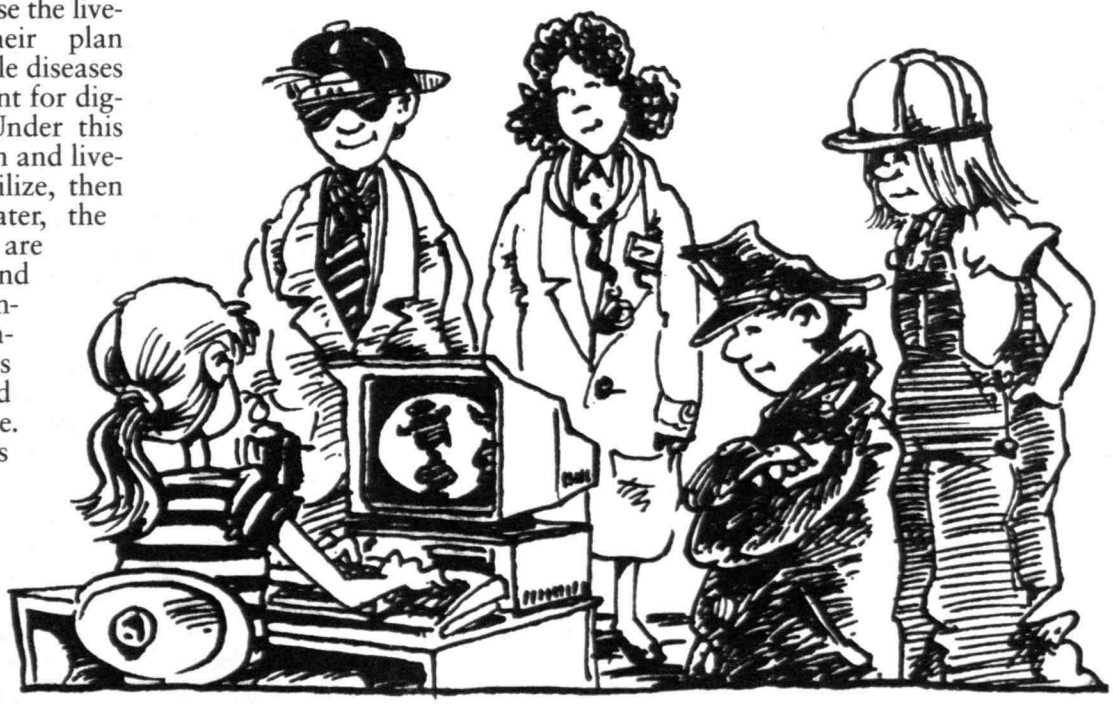
In one corner of an immaculate, chilled computer room, two high school teachers are trying to help their simulated population of East African nomads stay alive. With a few keystrokes and mouse clicks on a Macintosh computer, they start a vaccination program to prevent infectious diseases, then watch as the machine plots the effects of their work over the succeeding years. Death rates go down and people start living longer; with more people to feed, however, the nomads' cattle herds begin to decline. Within 10 years, more people than ever are dying of starvation.

The pair then goes back to year one. This time, to increase the livestock population, their plan includes preventing cattle diseases and providing equipment for digging watering holes. Under this scheme, both the human and livestock populations stabilize, then increase. Ten years later, the nomads and their cattle are thriving. But now the land is being grazed more intensively, eventually becoming arid. Within 20 years the country is plunged into a catastrophic famine.

As a relief effort, this simulation was a spectacular failure; but as a learning exercise, it holds a lot of promise. In a reform movement led by two emeritus professors from MIT, "system dynamics" exercises like this one are helping to turn K–12 classrooms around the United States into high-performance learning centers.

System dynamics is an approach to observing and analyzing any complex organization in a comprehensive manner: seeking to understand its structure, the interconnections between all its components, and how changes in any area will affect the whole system and its constituent parts over time. The discipline has its roots in engineering science, particularly in the development of feedback amplifiers for long-distance telephone lines at Bell Laboratories in the 1930s and the work of the MIT Servomechanisms Laboratory in the 1940s.

The basic building blocks of any system are simple "feedback loops" or "causal loops," a good example of which is the household thermostat: a device in which temperature is the trigger that turns a furnace on and off, in turn regulating temperature. But larger, more complex systems—like a society of East African nomads—are constructed of many interacting feedback loops, and a change in any one will affect all the others in dynamic ways.



ILLUSTRATIONS: JON MACINTOSH

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FEBRUARY/MARCH 1995

WHISTLING WHILE WE WORK

Last spring's patrol car on the Great Dome was news coast to coast; the MIT Museum's book on hacks has sold out its third printing; and the eruption of the MIT balloon could well be the most famous event that ever happened on the field of the Harvard stadium. The world thus was well prepared for the Ig Nobel Prize Ceremony and the Annals of Improbable Research *(see page 4) to originate on this campus. The Ig Nobels, for example, are covered by National Public Radio, the BBC, ABC News, CNN, distinguished publications such as* Science *and* Nature, *and the wire services. And it's a "slow day" when editor Marc Abrahams receives fewer than 30 e-mail messages from readers and/or potential contributors to the* Annals*—known to its friends by its initials,* AIR. *This human, not to mention hilarious, face that MIT offers to the world is surely winning us friends. Modern life almost defies parody; MIT is to be commended for keeping a noble tradition alive.*

—SUSAN LEWIS

System Dynamics for Kids

continued

Since the early 1960s, the principles of system dynamics have been extended to social systems, such as corporations, cities, ecosystems, and regional economies. The efforts of innovative educators to introduce these analytical tools into the classroom, as early as kindergarten, began only in the late 1980s, but already they are bearing fruit.

"Education has taught static snapshots of the real world. But the world's problems are dynamic," writes Jay Forrester, SM '45, the founder of system dynamics. Six years into his official retirement from the faculty of the Sloan School, he is the founder/director of the System Dynamics in Education project (operating with private funding under the aegis of Sloan) and a mentor for many K–12 educators.

"Missing from most education is direct treatment of the time dimension," Forrester explains. "What causes change from the past to the present and the present into the future? How do present decisions determine the future toward which we are moving?" Conventional teaching, he believes, ignores such questions, the answers to which "lie in the dynamic behavior of social, personal, and physical systems." Forrester is convinced this behavior can be taught and can be understood, even by very young children.

Nearly 300 teachers, administrators, and students gathered to hear Forrester's most recent ideas and to learn from other leading practitioners at a conference on "Systems Thinking and Dynamic Modeling in K–12 Education," held this past summer on the campus of Concord Academy in Concord, Mass.

In an open lab, they shared their latest computer software, including the African development model that is the work of teachers at Sunset High School in Beaverton, Ore. "I play the role of an ambassador from an East African country, and teams of students act as aid agencies like the Red Cross and World Vision," explains Matt Hiefield, a social studies teacher who developed the computer program with three of his colleagues.

Hiefield, who served in the Peace Corps in Mauritania, uses the simulation at the end of a unit on Africa. The nomadic group he presents to his students is self-sufficient but suffers from chronic hunger and persistent diseases. Almost invariably, he says, students are surprised to see their well-intentioned aid meaures making things worse. "At first they think 'The death rate is high and certain diseases are rampant, so let's vaccinate.' But this program allows us to see that the most apparent 'solution' may create more problems," says Hiefield.

There is no "correct" answer for this exercise. It is possible, however, to propose meaningful aid that is unlikely to throw the nomads' complex and delicate system of survival out of balance, provided each student team coordinates its efforts with the others, and they test assumptions of what works and what doesn't.

Forrester has been researching and documenting just how complicated social systems can be since the mid-1950s, when he moved from MIT's engineering labs to the Sloan School. In this new arena, Forrester's focus was on the behavior of corporations, the subject of his first book, *Industrial Dynamics*, in 1961. He subsequently expanded his field of interest to larger systems and in 1969 published *Urban Dynamics*, analyzing, in part, how government policies aimed at alleviating urban poverty often made cities poorer. Low-income housing projects, for instance, were intended to help the poor in economically depressed cities, but actually succeeded only in concentrating low-skilled people in cities where manufacturing jobs were declining, Forrester showed.

Forrester's *World Dynamics* in 1971 included simulation models that showed how exponential increases in population and consumption of natural resources would lead

to crises from pollution, crowding, and hunger—unless there were major changes in economic policies. His predictions are still hotly debated. His current research project is a huge model of the U.S. economy, which he is turning into a two-volume book.

Forrester's attention was originally brought to bear on K–12 education through his relationship with another well-known MIT professor: former Dean of Engineering Gordon S. Brown, '31, ScD '38. Brown was the head of the Servomechanisms Laboratory, where Forrester worked in the 1940s, and Brown encouraged the junior researcher to make his move to the Sloan School. The two have continued to share ideas and cite each other's work ever since.

In 1973, Brown retired to Tucson, Ariz., where he wound up having long discussions about the problems in local schools with his neighbor, a retired teacher. Brown decided that systems thinking and modeling methods could "help kids improve their interest in learning and not become dropouts," and he set out to champion a systems approach to education.

A pivot point in his lobbying activities came in the spring of 1988, when he took a Macintosh computer loaded with STELLA dynamic modeling software to a meeting with the superintendent of the local Catalina Foothills school district. The superintendent was intrigued by this quick demonstration and suggested that Brown meet Frank Draper, a biology teacher at Orange Grove Middle School. At that encounter, Brown suggested that Draper borrow the STELLA software for the weekend. It was an inspired gesture. "This is what I have always been looking for," Draper reported to Brown.

Brown and Draper were able to line up enough computers and software for Draper's classes when school began. As more teachers became interested, Brown helped the school secure a $150,000 contribution of hardware from Apple, then helped to link the program to support from MIT alumni. James Waters, '46, had been a supporter of the System Dynamics Group at MIT. Now Jim and his wife, Faith, provide the financial backbone of what's known as the Waters Grant Project, which supports innovative teaching and administration in seven schools in the Catalina Foothills district. Another supporter was Barry Richmond, who received a PhD in system dynamics from MIT in 1989. His company, High Performance Systems, which created the STELLA modeling program, provides software at discount rates to educators and sponsors workshops to train teachers.

The schools in the Waters Grant project provide valuable models of how systems learning can work. "Instead of hearing from a teacher or reading in a textbook that antibiotics kill bacteria, students simulated the role of a doctor discovering which minimum dose of penicillin is most effective in curing a case of strep throat," says Frank Draper. "Instead of laboring through the immune response, with its long list of names and actions," he continued, "students worked toward an operational understanding of the relation between their bodies and pathogens by changing antibiotic levels in an infected person's body." In a separate simulation, students played the roles of public health officials to determine "when a community should be immunized—before or after the flu hits town."

While many dynamic modeling exercises in schools make use of computers, machines are not always essential. Joan Yates, manager of the system dynamics track within the Waters Grant Project, estimates that about half of the middle school and high school projects monitored by her office are computer based.

However, even if they don't require a big investment in hardware, teachers cannot implement a systems approach on sheer inspiration alone, without resources and administrative and community support. In the mountain community of Conway, N.H., teachers had high school students create their own model based on a local forest to learn math, science, and English skills. The students explored the forest's potential yield in timber products and interviewed paper companies and the U.S. Forest Service to elicit different policy perspectives. The students then worked in teams to design management plans, which they presented to the Forest Service.

"It taught the kids to write reflectively and to make connections between economics, ecology, and government," teacher Helen Steele reported at the Concord conference. But the project required a Herculean effort by the teachers, all of whom were carrying full loads, to coordinate the work across disciplines. And by the end, only a handful of students had the motivation and concentration required to derive the full benefit from the experience, Steele admits.

OSTENSIBLE RETIREES JAY FORRESTER AND GORDON BROWN HAVE BEEN INSTRUMENTAL IN DEVELOPING A NOVEL APPROACH TO K–12 EDUCATION THAT TUCSON AND OTHER CITIES ARE EXPLORING.

System Dynamics for Kids
continued

Intensive, hands-on training for teachers and a program of full-time mentor teachers have been key ingredients in making systems thinking a success in Tucson. Gordon Brown says that much of the funding he helped generate has been used "to provide the release time for the teachers so they could change away from their regular paradigm." Learning system dynamics well enough to use it in the classroom is *not* something teachers can accomplish by "just reading about it," he observed.

"It's a very new set of ideas that are not easy to internalize," echoed Forrester. "There's no organized body of material to pick up and use. Everybody here is pioneering their own way." And aside from the efforts of Professor Nancy Roberts at Lesley College in Cambridge, Mass., Forrester knows of no other teacher-training programs in the United States employing system dynamics. In contrast, he notes that Norway, Finland, Sweden, and Denmark have formed a consortium to develop system dynamics applications for high school use.

Right now, there is anecdotal evidence but no hard data on the quality of student work based on dynamic models or on the effect of a systems approach in a classroom or school. Staff members and teachers in the Waters Grant Project are consulting educators who can help them measure the impact of this teaching and learning strategy. Solid results could persuade other U.S. school districts of its value. For Jay Forrester, teaching more students to "appreciate the nature of complexity and to look beyond their immediate setting in search of the fundamental causes of problems" is a mission of monumental importance.

In addressing the Concord conference, Forrester maintained that students "should develop optimism about understanding those problems of society that earlier generations have found so baffling. Inflation, wars, unfavorable balance of trade, and destruction of the environment have persisted for hundreds of years without public understanding of the causes. Such problems are too serious to be left to the self-appointed experts; the public must acquire the insights that permit participation in debates of such importance."

So what it comes down to is that Forrester and Brown really want to save the earth. Quite a retirement project. □

Note: Jay Forrester's books on system dynamics are available from Productivity Press, Portland, Ore.

Annals Of Improbable Research:

Injecting Truth in Rumor-Mongering

By Steve Nadis

Where do you go for the latest word regarding the aerodynamics of potato chips, the taxonomy of Barney the Dinosaur, or the effectiveness of Chinese fortune cookies? Who do you turn to for revealing X-rays of the rich and famous or pictures of bacteria that mimic ancient hieroglyphics?

There's only one, illogical choice—the *Annals of Improbable Research (AIR)*, the self-professed "journal of record for inflated research and personalities." The material presented in the annals, according to its editors, "is intended to be humorous and/or educational, and sometimes is." The first issue of this bimonthly magazine, which is published at the MIT Museum, came out in December 1994. However, an electronic version called "mini-*AIR*" has been successfully testing the virtual waters since May.

One of the most headline-grabbing projects sponsored by the* Annals of Improbable Research *and the MIT Museum is the annual Ig Nobel Prize ceremony—the science community at its most insane, not to mention inane. High points included the "spontaneous Fashion Show," featuring designs based on the Periodic Table of Elements (photo ❶ is Neon, ❸ is Iron); the "Interpretative Dance of the Electrons ❷, with the Nicola Hawkins Dancers and Nobel laureates William Lipscomb (in lab coat) and Richard Roberts, and ❹ a human spotlight.

Disclaimers note that the *Annals of Improbable Research* is in no way associated with the name of the *Journal of Irreproducible Results* (*JIR*) or the publishers of said journal, considered the world's oldest and most famous satirical science magazine. History, however, reveals a common, not to mention incestuous, thread. *AIR* was co-founded by *JIR's* two former editors, Alex Kohn, a virologist based at Tel Aviv University, and Marc Abrahams. Kohn founded *JIR* in 1955 and edited the journal through 1989. (During this era, he wrote a celebrated paper claiming that North America would sink from the weight of stored volumes of *National Geographic*.) Abrahams edited *JIR* from 1990 to 1994, when relations with the publisher, Blackwell Scientific Publications, deteriorated beyond repair.

"Blackwell publishes a lot of somber

medical journals, and their executives in England were never comfortable with the idea of publishing a journal that was intentionally funny," Abrahams explains. After four years of working under difficult conditions—he says he received little support or compensation for his efforts—Abrahams tried to buy rights to the name *Journal of Irreproducible Results*, but the price wasn't "anywhere close to reasonable." Starting a new magazine seemed like the only alternative.

When Abrahams moved his energies from *JIR* to *AIR* in May, all of *JIR*'s regular writers and columnists followed suit. Also along for the ride were the 40-odd ("some *very* odd") members of the editorial board, which included seven Nobel laureates, four MIT faculty members—Jerome Friedman (himself a Nobel recipient), Jerome Lettvin, Robert Rose, '58, ScD '61, and John Van Mannen—even Marilyn Vos Savant, a well-known columnist listed in the *Guiness Book of Records* for having the world's highest IQ. For their loyalty, those dignitaries are accorded the status of "AIR-head." Volunteers earn the more modest "AIRhead for a Day."

The obvious question, of course, is how did a publication with such low-brow aspirations end up at a lofty institution like MIT? "For years, people mistakenly assumed that *JIR* was an MIT publication," notes Warren Seamans, director of the MIT Museum. "No matter what we said, we couldn't change their minds." If they couldn't squelch an untrue rumor, there was no choice but to create a new, accurate rumor by starting a magazine that *is* an MIT publication. And who could argue with Seamans' underlying philosophy? "In this day and age, we need some laughs."

AIR, he claims, fits right in with the rich tradition of science humor at MIT, best exemplified in the long history of hacks—pranks demonstrating wit, ingenuity, and usually considerable technical skill. "For some reason, the pressures of this place encourage people to express themselves in humorous ways," Seamans submits. "It's part of a natural tendency to make humor out of the thing that's causing you the most pain."

In line with that "pain transformed into humor" theme, the Museum scraped together some start-up money to cover the costs of printing and distributing the first couple of issues of *AIR*, "but ultimately," says Seamans, "the magazine will have to stand on its own three feet." *AIR* is already off to an auspicious start, with excerpts appearing in a weekly syndicated column on the Internet, alongside such luminaries as Miss Manners, humorist and drive-in movie aficionado Joe Bob Briggs, and the cartoon strip *Dilbert*.

AIR's other online offering, *mini-AIR*, has about 20,000 subscribers, more than any other publication offered through the "Net." As of September, these subscribers represented some 58 countries—from North America, Australia, and Western Europe, along with some less likely outposts. "We've got a guy in Fiji who is still hanging on; Bulgaria, Namibia, Peru, and St. Lucia have one subscriber each," Abrahams notes. "We're starting to get readers from Japan, Russia, Romania, and Croatia, but none so far from China. Officials there are trying to keep *AIR* out, possibly because they think it would represent a Great Leap Backward."

By and large, *AIR* has benefited from good timing. "We started up just when the Internet magazines started taking off," Abrahams explains, and the e-mail version of *AIR* is very interactive. "We get a tremendous amount of correspondence, nearly to the point of being swamped." Perhaps the reader contributions most valued by the editors are the nominations for the Ig Nobel Prize, bestowed at a headline-grabbing annual

PHOTOS: MIT MUSEUM; MARK ABRAHAMS

Improbable Research

continued

awards ceremony in Cambridge that is jointly sponsored by *AIR* and the MIT Museum.

"The Ig Nobel Prize ceremony is the one activity of the year where all the mad scientists of the world can physically come together and create havoc," says Abrahams. "I suppose there's a place for Stockholm—somewhere in Sweden, I'm told—but these other people need a place to go, too."

Ordering information: To subscribe to mini-AIR, on the Internet, send e-mail to <listserv@mitvma.mit.edu>; the body of the message should include only <Subscribe mini-AIR> followed by your name. To subscribe to the *Annals of Improbable Research* ($19.95 per year) by e-mail, send your name, mailing address, and a credit card number and expiration date to <mitshop@mit.edu>. The fax number is (617) 253-8994. The mailing address is AIR, c/o The MIT Museum, 265 Massachusetts Ave., Cambridge, MA, 02139. Marc Abrahams' e-mail address is <air@mit.edu>. □

A Letter from Richard A. Jacobs, '56

Changing the Culture, Changing the Results

In his letter in the January issue of *Technology Review*, Alumni/ae Association President Gary Schweikhardt, SM '73, talked about the importance of the volunteer component in determining the character and success of this enterprise. What I'd like to talk about in this issue is an organizational experiment now in progress among the *staff* that is showing enormous promise for the Association, the Institute and—of great importance—for you, the alumni and alumnae of MIT.

The experiment has its roots in a meeting last March, when 17 members of the staff gathered to digest the implications of the Association's recently completed long-range strategy study, to consider new ways to better serve their constituents, and to absorb some training that would help them implement change. From the list of opportunities highlighted by the survey, customer service was selected as a test case, and a team was assembled to do something about it.

The eight-member group was multilevel, comprising managers, administrative staff, and support staff; and it was multi-functional, including staff from areas as diverse as activities, regional programs, the Alumni/ae Fund, information management, and *Technology Review*. In other words, this body, which came to be known as the AARGroup (Alumni/ae Association Re-engineering Group) brought together people who normally never sit around a table—as equals—considering the same issues.

The investment of time was considerable: in their first round, they met three hours per week from April until the end of November and shared specific information-gathering tasks between meetings, all while carrying on their usual responsibilities. There was one mandate: produce *real* results. There were ground rules: The group was assured that no one would lose his or her job or suffer pay cuts as a result of the changes they recommended. And although the Association managers are well aware that improved services must be provided from existing resources, the AARGroup was instructed to search out innovative solutions, leaving aside for the moment how they might fit in the budget.

The staff group marched to the words of Jack Welch, board chair at General Electric Corp., who has observed that "excellence comes from allowing people to accomplish what even they believed impossible."

The team identified three specific opportunities, the first of which dealt with standardizing and centralizing information. Alumni and alumnae are frequently frustrated when they telephone the Association with a question. The answer they receive often depends on the personal knowledge of a randomly encountered staff member. Or perhaps they experience a variation of the freshman shuffle: "I don't know, but let me transfer you to someone who might," says the first person to answer the phone. There is a pause, the process repeats. The alums often wind up sorry they asked.

To address this situation, the team defined a computer-based solution they called *infoshare*, a data base composed of relevant computer files from various branches of the Association. Once *infoshare* is up and running, all staff will have access to an array of commonly asked questions and well-thought-out answers; lists of volunteers, alumni/ae officers, committees, and contact people around MIT and around the country; schedules of Association-sponsored activities; and more. Because *infoshare* is based on information already gathered and maintained, it will not involve a continuing investment of resources.

Lest I forget: the use of *infoshare* will not alter the Association's basic rules governing the privacy of its members and the security of information in its data base. Requests from marketing organizations, for example, for information about MIT alumni/ae will be declined; meanwhile, questions from graduates about how to replace their brass rats will merit correct, consistent response.

Once the initial work is done to network the sources in the database, *infoshare* will be tested on the computers of a few staff members who frequently respond to alumni/ae queries. Once the kinks are out of the system, it will be installed throughout the Association, making the specialized information accumulated by particular groups available to all, even new or temporary staff. This is expected to be operational by the end of fiscal 1995 in June, and alumni/ae can expect to receive announcements of its readiness.

The next concern addressed by the AARGroup was internal communication. With a staff of some 90 people serving a constituency of more than 80,000, everybody is very busy in their own organizational "silos." It has been evident for some time that the right hands need to know more about what the left hands are doing, particularly if the Association is trying to implement change on a broad scale. The team decided to strengthen an existing, rather informal, newsletter so that information

could quickly and consistently be distributed to the staff now housed in four separate MIT buildings. Once the Association has more experience with this internal newsletter, it may feed into other communication objectives, such as the planned computer bulletin board for alumni/ae.

The AARGroup's most challenging undertaking deals with an area of great concern to alumni and alumnae—career assistance. With permanent jobs and career security seeming as obsolescent as the buggy whip, career assistance is an Association priority. The centerpiece of our effort to date is ProNet, a service regularly advertised in *Technology Review* and used by many MIT graduates. But more is needed.

When the team members reconvened in December, they planned to take up this topic, including consideration of a career-assistance program analogous to the Educational Council. Visualize, if you will, MIT-educated professionals in your region advising you on the intelligent pursuit of career change and opportunity. Some MIT clubs—Chicago and Northern California, among others—have sponsored such programs, and they have been well received. The time seems ripe to expand the concept.

Also on the docket for the team is the whole issue of orientation and training. The goal is to ensure that all staff have the skills and information they need to implement new and current programs.

Standardized, centralized information and expanded career services for the "customer," plus enhanced communication and enhanced training for staff, comprise the Association's first round of improvements in customer service.

The self-directed, multi-functional AARGroup established a model of defining needs and opportunities, establishing priorities, and conceptualizing beneficial change for you, the customer. They also astonished themselves with the sheer volume of work this disparate team ploughed through and the depth of understanding each member developed about the work that goes on in other branches of the Association. They gained enormous respect for colleagues they barely knew when the project started. It was the Jack Welch dictum all over.

Infoshare, an internal newsletter, a new career-assistance program for alumni/ae, and enhanced orientation and training for staff: if that were the end of it, a substantial accomplishment would be realized. But it is my belief that these customer-service initiatives are just a start. Now, the challenge is to extend the concept so that more can be accomplished, faster, and more staff brought into the process. The AARGroup can redefine its responsibilities and other kinds of teams and working groups can be assembled to meet new needs and then disbanded.

As new or improved services are spawned, and old, less-effective services eliminated, reduced, or redefined, many if not all staff jobs in the Association can be expected to change over time with regard to the nature of the assignment and challenge it presents. Results and effectiveness will be measured not merely in terms of adherence to the budget and goals but in terms of "customer satisfaction," as indicated by alumni/ae support for the Institute and participation in Association-sponsored activities.

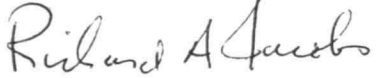
In such a corporate culture, staff will better understand and apply the concepts of "what counts? what's my job?" They will know, with more certainty, "how am I doing?" Classic organizational theory, which equates importance with "how many people do I supervise?" and creates boss-driven organizations, will be replaced by a value system based on serving the client, where the operative question is "what is my contribution?"

Eventually, the full measure of the successful organization will be realized when a manager walks into the office of Bill Hecht, the executive vice-president, or of Joe Collins, the director of the Alumni/ae Fund, and says "my job isn't required anymore. I'm ready for a new challenge." And he or she gets it!

This vision of meaningful, continuous, organizational improvement can also be applied to the reengineering efforts underway in the Institute at large. As many of you know, 60 to 70 percent of all reengineering efforts fail. MIT's program, so far, has avoided the typical pitfalls. The right things are being done, and they are being done the right way. Progress is evident. But just balancing the budget—albeit a key goal of reengineering—is not enough.

About a decade ago, MIT corrected a budget that was out of balance through expeditious, across-the-board cuts that hit efficient operations as hard as they hit inefficient ones. In time, the allocations began creeping up again, helping to bring about the current crisis. As a management consultant, I see these same unfortunate patterns being repeated over and over in much of industrial America. Companies that down-sized and restructured themselves only a few years ago are adding new positions and new activities. But little consideration is given to the factors that eat away at a company's financial strength; little effort is made to ensure that new services are funded by making existing services more cost effective. It's only a matter of time until the competitive squeeze returns, and a new cycle of restructuring is required.

There is a better way, and I think that the Alumni/ae Association offers a model for consideration. Reengineering—even when propelled by a massive effort, as MIT is exerting at present—is only a start. Uninterrupted, creative, intelligent improvement must become a way of life.



Immediate Past President, Association of Alumni and Alumnae of MIT.

ClassNotes

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Please send news for this column to: **Bill Langille,** secretary, Box 144 Gladstone, NJ 07934 (908) 234-0690

20 75th Reunion

Please send news for this column to: Class Notes Editor, *Technology Review*, 201 Vas sar St., Cambridge, MA 02139

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Through your loyal and generous support of the MIT Alumni/ae Fund for general administrative, educational, and research purposes, as well as specific items such as the Class of 1921 Scholarship Fund, we are delighted to pass along a brief summary of what your gifts to our scholarship monies have made possible for two brilliant students during the past year.

In obtaining information from the Financial Aid Office forwarded to us, it is most heartwarming to quote an Alumni/ae Association official who remarked: "I hope you are as impressed as I am with their activities. There do not seem to be enough hours in a day for all the schoolwork and outside endeavors in which these students have done so well."

The report tells us that the two recipients were Shamain Rosenberg and Thomas Lawson. Shamain now is a sophomore who has chosen chemical engineering as her major and plans to work in that field after receiving an undergraduate degree.

Although her coursework requires most of her time, she is deeply involved with her sorority, Sigma Kappa, and served as activities chair last year.

Thomas was graduated last June with a degree in urban studies and planning. While at MIT, he served as vice-president of his fraternity, worked as a tutor for high school students, and participated in other community service projects. He also was active as a member of the National Society of Black Engineers and he performed effectively as chief executive officer of the MIT Black Entrepreneurs Club.

Accept the plaudits of the entire MIT community for what your gifts have accomplished to back up and encourage these young people. Make certain you continue to be generous when the annual Alumni/ae appeal shortly arrives at your door. And please direct some class notes encouragement to your scribe by telling us your latest news, what you do in retirement, plus your favorite story of student life on the Charles.—**Carole A. Clarke,** president and secretary, 608 Union Lane, Brielle, NJ 08730-1423, (908) 528-8881; **Samuel E. Lunden,** assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274, (310) 833-1480

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Please send news for this column to: Class Notes Editor *Technology Review* 201 Vassar St. Cambridge, MA 02139

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No hits—no runs—no errors. Send news for this class to: **Royal Sterling,** secretary and president, 2350 Indian Creek Blvd. W., D-201, Vero Beach, FL 32966-5103, (407) 562-3937

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Please send news for this column to: Co-secretaries: **Katty Hereford,** 237 Hacienda Carmel, Carmel, CA 93923; Col. **I. Henry Stern,** 2840 S. Ocean, #54, Palm Beach, FL 33480

25 70th Reunion

The Alumni/ae Association has provided your secretary with an up-to-date mailing list of classmates. There have been few changes during the past year. Capt. **Nicholas Draim** has moved from Chambersburg, Pa., to Vienna, Va., **Walter Rhodo** from Lewisberg, Pa., to Cabin John, Md., and **Emanuel Tarplin** from Yonkers, N.Y., to Mansfield, Mass. **Archer Nickerson,** who has lived in Duxbury, Mass., for about 30 years, has moved with his wife, Dorothy, to a retirement home in No. Falmouth. A phone call assured me that he is quite contented with the location, which finds them only a few miles from their son. Mailing addresses are available for 83 classmates. Unfortunately, there is a similar number for whom we have no address and these people haven't been heard from in years.

As these notes are being prepared, October 1994, four classmates have indicated the 70th Reunion is in their plans. They are **Milt Salzman, Sam Spiker, Don Taber** and **Court Worthington.** I hope the number is much larger by now.

The passing of **Max Sandfield** in Dallas, Tex., on April 12, 1994, must be reported. Max designed the Temple Emanuel in Dallas. Dedicated in 1957, the temple was hailed by the *Encyclopedia Britannica* as "one of the handsomest synagogues in the United States." It was widely regarded as one of the finest combinations of art and architecture in the Southwest and received numerous design awards, including a 1957 Merit Award from the American Institute of Architects and the 25 Year Award from the Institute's Dallas branch. Max is survived by his wife, Carol, three sons, and two daughters.—**F. Leroy (Doc) Foster,** secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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Please send news for this column to: **Donald S. Cunningham,** secretary c/o 132 Middle St. Braintree, MA 02184

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Arthur H. Alden, Jr., of Mattapoisett, Mass., died June 12, 1994, after a long illness. He was born in Marlboro, Mass., grew up in North Weymouth and Quincy, Mass., and received an SB in chemical engineering at MIT. He was employed by the Cities Service Oil Co. for 40 years, becoming superintendent of East Coast Operations at Petty's Island, N.J., in 1954. A leader in his field, he was awarded 28 patents pertaining to petrochemical process and lubrication, providing a great contribution to the motoring public.

A 10th-generation descendant of Pilgrims John Alden and Priscilla Mullens, Arthur was directly related to eight *Mayflower* passengers. Certainly the blueist of the bluebloods. He is survived by a son, two daughters, eight grandchildren, and seven great-grandchildren.

From a good telephone call with **Richard Hawkins,** who lives in a new condominium in Hull, Mass., we learned that he celebrated his 90th last February with a big party of 40 people. Living alone, he has made a particular hobby of taking care of himself. Two years ago he was hospitalized for stress and since then has followed the motto "take it easy." He no longer drives and has fond memories of his sloop *Hinamoa*. The condo is in a fine location overlooking Boston harbor, with five lighthouses in sight and a cosmopolitan group of 150 retirees and the rest are of all ages. Give him a call at (617) 925-4270.

In the latest list from the Alumni/ae Association we have 122 classmates with known addresses. And practically all of us in our 90s. Congratulations to all!—**Joseph C. Burley,** secretary, 1 Harbourside Dr., Delray Beach, FL 33483; **Lawrence B. Grew,** assistant secretary, 21 Yowago Ave., Branford, CT 06405

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The main occupation of our classmates these days is not that of making news, though many are leading relatively active lives. Therefore we are again reduced to reporting deaths, of which there are three.

James Clifton Edgar passed away March 6, 1994, at Cary, N.C. **Benjamin Kent Hough, Jr.,** died March 30, 1994, in Alexandria, Va. "Bennie" was a longtime resident of Ithaca, N.Y., where he taught at the Cornell School of

Engineering as a professor of structural engineering until his retirement. He also maintained a private consulting practice. In 1980 he was selected Engineer of the Year by the Ithaca section of the American Society of Engineers.

Henry Napoleon LaCroix died September 26, 1994, in West Orange, N.J. "Nap" retired as an international chemical engineer with the Foster Wheeler Co., where he specialized in oil refining, nuclear energy design, and chemical plant design while managing projects worldwide.

We offer our condolences to family and friends.—**Ernest H. Knight**, secretary, 168 Ai Plummer Rd., Raymond, ME 04071-6549

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Please send news for this column to:
Vincent F. "Jerry" Gardner
51 Hill Rd.
Belmont, MA 02178

30 65th Reunion

The *Review*'s Class Notes deadline for this issue was October 28 and for the reasons given below I had a bit of trouble meeting it. During the week of October 10, Louise and I went to New York, primarily to attend my 55th Columbia Law School reunion. The reunion program included a luncheon at Morningside Heights and a dinner at the University Club in mid-town. While in New York we were fortunately able to get tickets to a performance of the new production of *Showboat* at the George Gershwin Theater. Also I joined my former partners of Curtis, Morris & Safford at one of their weekly firm luncheons at the Cornell Club. I am now the oldest surviving partner and gave a short talk on the early history of the firm, which now numbers 30 lawyers.

During the week of October 17, we took a four-day trip to North Carolina, visiting two of Louise's nieces, a nephew, and their spouses. Our trip included a visit to Swan Quarter where Louise was born and grew up, a ferry trip from Swan Quarter across Pamlico Sound to Ocracoke Island on the Outer Banks, then past Cape Hatteras to Roanoke Island, the site of the "lost colony"— the abortive effort to establish a British colony in North America before Jamestown was settled in 1607. We are now resting up for a bit.

In last month's Notes I indicated that the first notice about our 65th Reunion would go out in October. However I have just learned from **Yicka Herbert** that it will not go out until the first part of November. I hope I will be able to report some classmate reactions to this notice next month. . . . **Bill Jackson** reports that he still works for Pitt-Des Moines, Inc., five days a week, an average of five hours a day. He says: "I look after the company contributions, the audit committee, the executive committee, pension investment, etc. I also carry the title, chairman emeritus." He still plays 18 holes of golf about once a week. He and his new wife, Margaret, have a total of 15 grandchildren. He says Bunny and **Jack Bennett** stopped in to see them on their way from Chautauqua, N.Y., to their home in Highlands, N.C.

In a letter I received from **Jack Latham**, he says: "Recently I have attended a number of Republican National Committee meetings in Washington. They are expecting to make out very well next month, but are deeply concerned over lack of cash in their funds." By the time you read these Notes you will be able to evaluate this forecast quite accurately. . . . As previously reported, **Robert M. (Jake) Jacobs** retired about 10 years ago as senior vice-president and a director of Stone and Webster Engineering Corp. in Boston. Since his retirement he has traveled extensively and while at home enjoys woodworking, gardening, and golf. His son Bradley is a former president of the Society of American Magicians and arranges their conventions. In this capacity he crosses paths from time to time with **Morris Young** who, as often reported in the Notes, has long been interested in this field. Jake is planning to attend the 65th Reunion.

We have at hand a notice of the death of another classmate. **Ludwig Jandris** died in Northampton, Mass., last August 15th. Lud spent his entire career in the construction industry, except for the WWII period when he served as a captain in the Army Corps of Engineers. After graduating in Course XVII, he initially worked with his father doing business as Jandris Construction Co. and in due course became president of the company. In 1958, after a short stint as city engineer in Gardner, Mass., he went to work with Daniel O'Connell's Sons in Holyoke. O'Connell was a 1929 graduate of MIT. Lud's work involved the construction of schools, hospitals, commercial buildings, power plants, bridges, and roads. He retired in 1973 and thereafter took courses in both German and Spanish at a local high school. He and his wife, Cornelia, were living in South Hadley at the time of his death. In addition to Cornelia he is survived by a son and three daughters.—**Gordon K. Lister**, secretary, Apt.40, 5707 Williamsburg Landing Dr., Williamsburg, VA 23185

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Please send news for this column to:
Wyman P. Boynton, secretary
668 Middle St.
Portsmouth, NH 03801

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To date we have received 35 replies to our letter describing our proposed mini-reunion in Hawaii in April 1995. Seven have asked to be kept informed as they may have some interest in the trip, 28 for various reasons would not consider going, and a few gave me some information which I now pass on to you.

Richard W. Berry writes, "After my 50 years plus with United Fruit Co., I am sorry I cannot join this top banana event." . . . **Ben Chadwick** writes that he and his wife, Marion, still travel a lot. They attended three elder hostels this year. They have been to Hawaii, which they enjoyed very much. At present, however, Marion has two plastic knees, and Ben is a bit wobbly. However, they still hope to keep traveling.

Mrs. **Alexander Chaplik** tells us that Alex passed away in June 1994. We will pass on obituary information when we receive it. . . . Barbara Flatley writes that **Nick Flatley** lost his eyesight and has just returned from three weeks in the hospital. Nick, we hope to hear from you soon with good reports about you. . . . **Robert B. Follansbee** writes that he and Susalee have just celebrated their 50th anniversary. For the last 17 years they have spent six months in Maine and six months in Florida. This year will be the last time in Florida. Brrr!

Harry L. Johnson writes, "Still alive and kicking. I worry about things I can do nothing about (like the national deficit)." . . . **James Snow** criticizes our proposed trip to Hawaii. We should have made reunion plans that would have been easier on us physically and financially. . . . **Lee Tybruski** writes, "Sorry, I'm too old. I spent a lot of time in Hawaii during the war. It's a great place and you'll have a grand time. Regards to all." . . . **Carl Wahlström** is sorry but cannot go with us to Hawaii because he had a stroke on his 86th birthday and now is in a wheelchair. . . . **Charles E. McCormack** has been coping with multiple myeloma for the past four years. He enjoys the class notes and sends his regards to all his classmates.

F.R. Morral writes, "Thanks for the invitation to the '32 mini-reunion. It was nice of [**Manley**] **St. Denis**, a good friend of **Juan Serrallach**, to organize the trip as the latter did some years ago in Spain which I attended, since Juan was a good friend of mine. In addition to attending MIT, we had been students at the German school of Barcelona in the 1920s.

"My wife and I have made plans to visit her family in Sweden late in April '95, otherwise I would have been interested, since I have never been beyond the western border of the mainland of the USA.

"You ask for news. Some seven years ago they had to remove a tumor from above my left ear. Several nerves were damaged, so now I have no hearing in my left ear, and for safety's sake no more driving or bicycle riding. I do a lot of reading, large print books, 6–8 per month—adventure, biography, mystery. Luckily, there are many of these books available. I walk 12–20 blocks, and in the summer try to swim in an open pool some 200 meters. I have written and published a number of historical articles on metallurgy. Wishing the travelers a good trip and before that a good Thanksgiving, Christmas, and New Year. Greet the St. Denises for me. I have not seen them since the Spain trip mentioned above."

Eric Newman says that he is glad to have the opportunity to say "hello." He won't be able to make the Hawaii trip. He wants to say that he and his wife are thrilled with the new head of "our" lab in the Mechanical Engineering Department at the Institute. . . . **William B. Pearce** writes that Midge and he would like to go but with their present problems they will not sign up now.—**Melvin Castleman**, secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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George "Hardy" Ropes reports that he and wife Catherine have been oscillating back and forth between Golden Bridge, N.Y., and Marshfield, Mass., where they go in the summer. George Ropes's attachment to MIT began with his father, who studied architecture at MIT and subsequently practiced in that profession almost all his life in Detroit. George's son, George H. Ropes, Jr., earned a master's degree at MIT in political science in 1978. In our 60th Reunion Classbook, one of

his three daughters is reported to have addressed MIT scientists on the effect of global warming on crops worldwide. George never had the inclination to follow in his father's footsteps, preferring mathematics even to this day, saying that he is currently programming the teaching of decimals to junior high school students. Statistically, our George is a Course XV, business and engineering administration, graduate with fraternity affiliation XO. For those of you with the 25th Reunion Classbook, you can see George and his family up a tree in a very appealing 1956 photo.

Having nothing further to report I am taking the liberty of promoting a Class of 1933 Memorial Fund before we become extinct. We should look into it so that this project may be funded adequately. Five other classes have such a fund. *In Memorium* (an MIT publication) lists seven members of our Class in its 1989–90 issue. Four of this number are memorialized with an endowment fund benefiting MIT in perpetuity. Looking towards our coming 62nd Reunion we should have more input on this same subject for discussion. Hope you're planning to be there!—**Berj Tashjian,** secretary, 1245 Briarwood Lane, Northbrook, IL 60062

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Some of our classmates are still busy in their original field of endeavor. One of these is **Jerry Minter**. Jerry is still running the company he started and working on new ideas. He developed a system of early warning devices for approaching aircraft, which was highly effective, but he was not happy with the way it took care of the horizontal bearing. So he developed a new system to correct the deficiency, filed a patent application for it in April 1990, and was granted the patent in June 1993. The present system uses direct communication between the two planes with a special code about once per second on the same frequency as the FAA ground station. A computer advises the pilot to climb or descend to avoid a collision. The new device uses four quadrant antennae with four receivers. When a plane approaches, there will be eight horizontal bearings in less than a second, as opposed to 20 seconds at present. At the same time it eliminates the clutter of the present system. Not satisfied with the improvements covered by his new patent, Jerry is currently filing a patent for a device that will provide a simultaneous visual and audible signal to the pilot, advising what evasive action to take. He is also working hard at getting the FAA to start using the system covered by his 1993 patent. The patent was 40 pages long, and Jerry provided a solid sheet, single-spaced, explaining it. I hope this condensation is accurate.

Vice-President **Russ Hastings** has also been active. Last November he traveled to Beijing, China, as a representative of the American National Standards Institute. He attended a meeting of the International Standards Organization. One of the most important subjects was to try to reach agreement on the dimensions of a proposed larger freight container that would be 8 1/2 feet wide by 9 1/2 feet high and a little over 48 feet long. He noted many changes in China since he was there in 1985 with his wife, Mary. In the cities they visited then, new buildings under construction were only six stories high. This time they were 20 stories or more. The commuter bicycle traffic used to occupy two-thirds of the width of the street. Now, automobiles and trucks occupy two thirds, and the bicycles only one third.

A lovely letter from **Charlie Lucke**'s wife, Agness. She enjoyed reading about the activities at the 60th Reunion. She and Charlie were faithful reunion attendees and she has many friends in the class. She also reports that her son, daughter-in-law, and herself took Lee and **Ed Chiswell** to lunch in San Jose, Calif., and later attended his 80th birthday celebration held in Mill Valley, given by his children and stepchildren. At 80, Ed must be one of the youngest members of the class. Anyone any younger? Agness goes on to say that Charlie was prominent in class activities, and most active as a member of the crew for four years. After graduation, he served several terms as class president. Charlie started working for the Wilson Mechanical Instrument Co. in New York City. After it was acquired by American Chain and Cable, it was moved to Bridgeport, Conn., where Charlie carried on as plant manager. He later became plant manager for all of ACCO's Bridgeport operations. In 1967 he was made VP of operations for the company. In 1965 he was selected to head up the newly formed Wire Products group, which included the manufacture and sale of wire rope, chain-link fencing, welding wire, and automotive control cables. He also acted as chair for the Bridgeport area for a scholarship committee, which annually awards college scholarships to students in towns where ACCO has facilities. Charlie and Agness were both active in Bridgeport social and community activities. The Luckes have a son, Robert, a daughter, Jane, and two grandchildren.

As we wrote this Houston was having about three feet of rain. We knew that vice-president **Ed Asch** and his wife lived on Tupper Lake Drive, and we were concerned for their safety. A call to Ed found that they were high and dry above the bayous, which are not too far away, but they are at an elevation of about 40 feet. Tupper Lake is in upstate New York and the name of his street came from a homesick developer from New York. Ed reports that he and Annette have rented a house in London near Marble Arch, just a stone's throw from where your secretary lived for 18 months while on assignment in Europe. They will be there for a month and will return in early December. . . . Ed had a letter from **Bob Roulston**. All is well with the Roulstons. They were just closing up their home in Ossipee, N.H., and he and Barbara were heading south to Ocala, Fla. Ocala is also the home of classmate **Fred Barrett** whom we have not seen for some time.

In the October issue of the *Review*, we had greetings from **Stanley Knight,** Course XIV, which had accompanied a contribution to the Alumni/ae Fund in May. Today's mail brings a letter from his wife, Ethel, with the sad message that Stan died suddenly on May 12, 1994, of a heart attack. Our story in the October issue prompted Ethel to write. The only omission in the October issue was that Stan was elected to the Honorary Society, Sigma Xi, when he received a master's degree in 1935. Ethel sends greetings to her friends in the class, and we, in turn, send our deepest sympathy to Ethel. . . . Saw **Lou Frank**'s widow, Frankie Frank. She commented that the 60th Reunion was the best ever. She is very

busy, "too busy," she says. She is a consultant for local physicians and three nursing homes. She works with them to evaluate patient's needs to see that they are placed in a nursing home that best meets their needs.

The Alumni/ae Association has confirmed the death of **Win Brown**. A letter of sympathy has been sent to the family from the class. Following graduation, Win took a master's in chemistry in 1935. He was associated with the Mellon Institute of Industrial Research at Pittsburgh from 1935 to 1941. While there, he earned a doctorate in chemistry, married Eliza Evans Crannell (1940), and became a fellow of the Mellon Institute before going into the service in 1941. He served as a captain in the CWS and was stationed at the Edgewood Arsenal in Maryland. He then joined Eastman Kodak's Distillation Products Division as a technical associate. He was with Eastman Kodak for the rest of his working career, living in Rochester, N.Y. He developed several patents on Vitamin processes, particularly Vitamin A. Following retirement, the family moved to Winchester, Va. He was a member of the American Chemical Society, and the American Institute of Chemical Engineering. Besides his wife, he leaves five children and seven grandchildren. The whole family were avid skiers, and the Browns particularly liked to travel.

This concludes our notes for this month. Will you write me, please, and let us have news of you, earth-shaking or not?—**Carl H. Wilson**, secretary, 1820 Avenida del Mundo, #309, Coronado, CA 92118, (619) 435-3712

35 60th Reunion

Mortimer Rosenbaum phoned to let me know that our classmate **Karl Achterkirchen** died September 29, 1994, after a long illness. He was in Course XVI and earned an SM in 1937. The next year he went to San Diego to work for General Dynamics for two years before going to Washington, D.C., and joining the FAA. In 1941 he joined Lockheed Aircraft in Burbank, Calif., and spent 18 years with them as product engineer on fighter aircraft. In the process he made 65 trips to 9 European countries. After 1955, Karl, with his wife, Doris, used to travel with Mortimer Rosenbaum and his wife, Lorraine. Karl is survived by his wife, three sons, and two grandchildren. I am sending our condolences.

Herbert G. Anderton, Jr., writes a follow-up letter to his first letter in 59 years (see October '94 Class Notes) telling us that his wife died on July 17th and that he became a great-grandfather on September 1st.

By the time you read this you will have received details for our 60th Reunion and have already signed up to be there.—**Allan Q. Mowatt**, secretary, 715 N. Broadway #257, Escondido, CA 92025, (619) 432-6446

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An apology to **Aldo Bagnulo** for the printer's two errors in his surname's first syllable (May-June 1994 "Bang", and October "Beg") brings this lighthearted response: "No bother—we became accustomed to such long ago. We kept track briefly and listed 10 variations. Last September Helen and I took a cruise to Montreal via the Cape Cod Canal, Nova Scotia, and the Saint Lawrence. In cool weather she wore an MIT sweatshirt and was surprised at the number of passengers starting conversations. She also has a Tech T-shirt and calls them her 'bragging shirts'." After the 45th Reunion my wife, Phoebe, liked to use the souvenir tote bag on special occasions.

Fred Watson's reminiscence about Nobel Laureate **Bob Woodward** (November/December '94) triggered further memories. We heard from **Alice Kimball**, Fred himself, and **Roman Ortynsky**. To its great credit, the Institute recognized Bob's unusual talent early, allowed him to shape his own curriculum, and provided a laboratory for his exclusive use in research. Quoting Professor Norris: "We did for Woodward what we have done for no other student in our department. We think he will make a name for himself." In 1979, when Woodward died at age 62, his then colleague Roald Hoffman of Cornell spoke of his phenomenal intuition for theory, and "we had just begun work in a field new to both of us—design of molecular systems with novel conducting properties." **Fred Watson** adds: "No question he was a genius, and the world lost a great scientist when he died. I share the opinion that we might be well advanced in superconductors had he lived longer." **Roman Ortynsky** obtained some of the above information from an old issue of *Chemical & Engineering News*. Ro had a wide-ranging career in R&D with Shell Oil and Army Ordnance (five patents).

Herb Borden's note transmitting **Lou Stahl**'s obituary concluded, "Kitty still plays golf two mornings a week, and I played the clarinet in two parades at the Shrine convention in Denver. We went to see the Air Force Academy, which our grandson hopes to attend." . . . On a call to **Rob Wead** for the outcome of a feasibility study on a four-year college for Maui Island (action expected this year), he told of still another appointment. He is on the board that will review plans to use annual federal block grants for mental health services in seven Pacific Rim states and assorted island territories, including Guam, the Marshalls, and Palau. After much preliminary homework, the seven reviewers will meet for three days in Portland, Ore., to approve or order revisions.

More returns from the canvass: **Edwin Hulbert** (Course XVI), after Navy service in WWII, built sheet-plastic-fabricating machinery for 15 years, then went with Hartland Plastics of Wisconsin for 21, becoming vice-president and general manager. He held a private pilot's license from 1930 to 1975, and is a longtime member of Experimental Aircraft Association, which annually attracts thousands of flyers worldwide to Oshkosh with their home-built craft. . . . **Frederick Cotton** (Course XV) has owned and operated Cotton Real Estate and Construction Co. in the Swampscott, Mass., and Wolfeboro, N.H., areas, specializing in custom designed homes. He recalls undergraduate friends **Ron Beckman**, a classmate from grammar school and football teammate at Swampscott H.S., and **Jim Carr** (who was in construction related business). . . . **Richard Patterson** (Course VI) did design, management, and construction supervision of power plants, research facilities, and nuclear production plants at Arthur Nelson Engineers-Boston with **Russ Bandomer** and **Warren Dannenberg**, at GE-Schenectady

and Fort Wayne, Charles T. Main Inc.-Boston, and lastly was director and executive vice-president of Ganteaume & McMullen-Boston. As undergraduates, Dick and **Harry Foster**, while hitchhiking in New Hampshire, were picked up as vagrants by the rural police, but were released uncharged after one night in warm beds in a jail cell.

Cheers for the lives of **Lawrence Peterson** (Course VI-A) and **Julian Rifkin** (Course XV)! Larry died October 3 after a long, courageous bout with cancer, attended throughout by his wife, Lillian, a Russell Sage graduate R.N. Our careers were somewhat parallel—five Institute years for SB's and SM's, brief electrical work for GE, then into business administration. Larry was manager of finance for GE's power tube department and taught courses in business there. He was active in the National Association of Accountants, his church, Scouting, the guild of Organists, and Schenectady Historical Society. Most of all for us, he was a strong advocate of MIT and Class Notes. He and Lillian attended reunions and mini-reunions almost without fail. A note from his son Don told of his wearing his MIT Beaver tie at the end.

Julian Rifkin was in the theater business from graduation, except for Army WWII duty. After running a summer stock company, he built a chain of indoor and outdoor movie theaters, and became chairman of Cinema Centers and consultant to Hoyt Cinemas. As president of the National Association of Owners, he worked to establish the voluntary movie rating system and was chairman of the code and rating committee. He had a private pilot's license, and flew many missions of mercy in the Northeast for Air Lifeline. Julian died August 5, also of cancer. As of this writing in October, his widow, Leah, had just returned from a grandson's wedding in Seattle—"It was beautiful, but difficult for me without Julian to share it."—**Frank L. Phillips**, secretary, 1105 Calle Catalina, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Rose and I spent a pleasant evening with Marge and **Dick Young** and Joan and **Bob Rudy** (who were in Boston to attend the MIT Council for the Arts meeting). Unfortunately, Ruth and **Phil Peters** were unable to join us this year because of Ruth's frail health. Hope Ruth will improve greatly with her new medication.

Sidney Mank writes, "Dot and I live on five acres in the country in a wonderful small town, Washington, Va. We have a full life, involved with community affairs: library work, head up a loan closet of convalescent aids at no charge to the community, retired from 14 years as a Lion. We have a wonderful vegetable garden and five acres of lawn to mow. Did our traveling some years ago—Europe and Caribbean countries. Retired as a lieutenant commander in the Navy in 1947 (Sea Bees). Healthwise not doing too well. Cancer took my left arm at the elbow, and prostate problems and a pacemaker restrict my ability to do much work, but I still can function. See **Harry Corman, Link Herzeca**, and **Al Wynot** occasionally. Still remember your Model A Ford at MIT survey camp in Maine." (And **Joe Smedile** and **Ralph Webster** remember that Ford well, too.)

A welcome note from **Joe Engel**: "Still manage to play four to six rounds of golf each week even though handicap has climbed to 26. Put 14,000 miles on the car this summer with four trips of two weeks each. Just returned from a few days at the Cloisters—Sea Island, Ga. It remains a grand deluxe vacation spot in the true Southern tradition. Oldest daughter recently featured in the *New York Times* business section (October 9, 1994): "Mommies Find Return to Fast Track Slow Going."

Rutherford Harris notified the MIT Alumni/ae Association that **Robert L. Johnson** of Quechee, Vt., died on September 5, 1994. He is survived by his wife, Patricia. We extend our deep sympathy to the Johnson family.—**Robert H. Thorson**, secretary, 66 Swan Rd., Winchester, MA 01890; **Leonard A. Seder**, assistant secretary, 1010 Waltham St., #342B, Lexington, MA 02173

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Our next mini-reunion will be held in a private dining room at the Wayside Inn in Sudbury, Mass., with dinner Saturday June 17, 1995, and with rooms available for the night. This timing will allow full participation in Friday's Technology Day at the Institute as well as participation in Cardinal and Gray activities on Thursday and Saturday. The new place and day of the week will be a change from our usual dinners at Endicott House, but as you know we have not been able to provide

Endicott House with enough people occupying rooms overnight to allow them to continue to accommodate us as they have in the past. The Wayside Inn will handle the dinner regardless of the number who wish to stay overnight.

Changing the day and place of our reunion dinner was one of the items accomplished at a meeting in **Norm Levanthal**'s Beacon Construction office on Rowes Wharf in Boston just before the Alumni/ae Leadership Conference (ALC) September 23–24, 1994. Attending the meeting were **Norm Bedford, Lew Bruneau, Ed Hadley, Saul Kaufman, Fred Kolb, Norm Levanthal,** and **Paul O'Connell. Norm Bedford** and **Saul Kaufman** were named co-chairmen for our 60th reunion.

The ALC was attended by your class president, vice-president, and secretary (Fred Kolb, Paul O'Connell, and Paul des Jardins). On Friday afternoon we participated in a class officers' workshop devoted to a series of exercises to discover more about our individual style of interacting from the standpoint of directing, coaching, supporting, and delegating. This probing enabled us to find where our normal inclinations and experience have led us. The situations were classified according to the amount of support and direction that needed to be given. The style of leadership in any interaction depends on the amount of commitment and competence the person undertaking a task for you brings to the task. The leader has to decide how much delegating, supporting, coaching, and directing should be applied. This means he should work on the basis: "you decide;" "let's talk, we'll decide;" "let's talk, I'll decide;" or "I'll decide." The workshop was stimulating and well received.

Friday evening Fred Kolb attended a panel discussion by seasoned Educational Councilors and participated in some hands-on practice sessions. (See *TR* January 1995, pages MIT8–14 for ALC story.) It was encouraging to hear these talented people speak, and those of us who were privileged to participate now have a better means of interpreting the Notes and articles that appear in the newspapers and *Technology Review*.—**Paul R. Des Jardins,** secretary, 6251 Old Dominion Dr., Apt. 310, McLean, VA 22101-4807, (703) 534-4813; **Gretchen Birge,** assistant secretary, 233 Carroll St., Apt. 202, Sunnyvale, CA 94086-6264, (408) 736-5011

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George Beesley and Eleanor were honored last September 24 when George received the Harold E. Lobdell '17 Distinguished Service Award. It is given in recognition of valuable alumni/ae relations services to the Alumni/ae Association and/or the Institute that is of special depth over a sustained period. The citation reads: ". . .for his support spanning over four decades and including service as 1939 class president, reunion chair, co-chair of the 50th Reunion, solicitor with a personal solicitation program, member of the former Alumni/ae Council, and member of the Technology Day Committee. His commitment, enthusiasm, and modesty are a great asset to the Institute."

George joins other 1939 classmates chosen from approximately 95,000 MIT Alumni/ae and who volunteered extra benefits to the Institute. Other classmates honored include **Jim Barton** and **Pete Bernays** with the Bronze Beaver Award, **Ernie Kaswell** and **Hal Seykota** with the Harold E. Lobdell '17 Distinguished Service Award, and **Burkhart Kleinhofer** with the George B. Morgan '40 Award. Also, the MIT Corporation recognized **Richard J. Donohoe** with the Corporate Leadership Award, and **Harold J. Muckley** as MIT Corporation Emeritus Life Member. Also, 25 graduates of the 1939 Class were among 1,100 alumni/ae recognized by name for significant donations each made to MIT's Capital Campaign via the Sustaining Fellows, who generated $710 million as of November 1992.

Bob Withington and Betsy, and **Hans Bebie** and Austie completed a three-week tour of China, their first. They learned China has about one-quarter of all people on planet Earth, all of them crowded into an area about the size of the USA. While China has nine cities with populations between 2.5 and 7 million, the country is still underdeveloped, according to European and Western norms. About 83 USA-clothed persons were in the tour group and their unusual appearances stimulated curiosity and staring by friendly Chinese Nationals, the majority of whom dress to work small plots from which they extract a minimum, no-frills existence. The tour guide was a well-informed young lady who was competent, considerate, and efficient.

Al Thackara appreciated being able to visit at the 55th Reunion with Jim Barton, **Joe Dana, Fred Grant, Bob Saunders, John Herlihy, Barry Graham, Larry Perkins,** and **Bill Pulver.** Al wrote: "It is sad to see here, in Emerald Bay, Calif., 60 of our 500 homes totally destroyed by the October 1993 fire. Our house was saved, and we later replaced our wood shake roof with fireproof shingles." . . . **Tom Blakistone** and Olive are presenting six plays during the 1994–95 season (their thirteenth) in their North Coast Repertory Theater at Solana Beach, Calif. Tom was invited by the Southern California Educational Theater Association to conduct a workshop on management practices in small theaters. Well received at the workshop was Tom's report about cosmic downscaling from an idea he read in the *Sloan School Journal* to manage his theater. For exercise, Tom jogs and does weeklong backpacking in the High Sierras at a 12,000-foot elevation. At this writing, Tom and Olive are at sea level in the South Pacific examining Balinese culture.

Joe Dana fell while playing tennis on Cape Cod. Jean reports the good news that he is convalescing steadily. . . . Bill Pulver and Adie summered in Lakeville, Conn. They report a new video on golf did not cause strokes increase per game, and a sudden summer squall did not overturn their 14.2-foot sloop.

We are saddened by news of the death, on October 22, 1994, of **James W. Barton,** 77, at the Lakeview Gardens Convalescent Center near Bellevue, Wash. He earned two degrees at MIT: an SB in business and aeronautical engineering, and an SM at the Sloan School. His career included leadership for his community, for Boeing, and for MIT. For the town of Hunts Point, Wash., he was reelected 10 years as councilman and 20 years as mayor. A park was named in his honor. After 44 years with Boeing, he retired as manager of its International Corp. For MIT, he served on the board of directors of the Alumni/ae Association and the Enterprise Forum of Puget Sound. He

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received the Bronze Beaver Award for distinguished service in 1971. He was an honorary member of the MIT Corporation Development Committee, an Alumni/ae Council life member, and, as 50th Reunion Class Gift chair, he led in raising $5,300,000 for MIT, thus setting a new record for MIT Class Reunion Gifts. In spite of battling multiple sclerosis for 30 years, he remained ever-cheerful and productive, immeasurably assisted always by the loving care of his wife, Mary, and their family.—**Hal Seykota,** secretary, 2853 Claremont Dr., Tacoma, WA 98407

40 55th Reunion

Following is the end of the list of missing members of our class. If anyone has any information concerning these or any of those previously listed, please let me know. **Gary Steven, William H. Stone, Kenneth Yaoyuan Sze, Theodore D. Thomas, Raymond S. Turner, Tui Voodhiguila, Robert M. Weiss, Richard H. Wheeler, Jr., Miriam R. White,** and **George Wirkosky.**

A letter from **Walter Helmreich** provided the information concerning the Alumni/ae Fund giving for FY94 that was included in last month's column. I had received it directly from the Alumni/ae Association.

About the time that this is being written, the last complete mailing about the 55th Reunion in June 1995 will be mailed. By now, I hope many of you have responded with your intentions to attend all or part of the activities. We look forward to seeing you at that time.

In the meantime, please write or call with any pertinent information or anecdotes for these Class Notes.—**Richard E. Gladstone,** secretary, 250 Hammond Pond Parkway, 1205 S, Chestnut Hill, MA 02167-1528, (617) 969-5161

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Another month, another empty envelope from MIT, and an almost empty mail box. There are some advantages. No obituaries! Two faithful correspondents provide the only news of classmates' activities. President **Sepp Dietzgen** writes: "We had a hectic summer moving into our not-quite-completed retirement house—so many possessions to get rid of." From previous correspondence, which I can't find, I believe the house is located adjacent to his former residence, which he hopes "his kids" will occupy.

Ivor Collins, our first and only treasurer, writes, "Shirley and I are looking forward to turning over the monthly internal/external publication of our retirement community at year-end. Then I'll be picking up the job of secretary of the Residents Association. Shirley is on the search committee for an associate minister of our church.

"Our sons have new jobs in the same organizations. Bruce is on the New York Transit's $640 million project to complete the 63rd

St./Queens Blvd. connection. Alan is now principal engineer for public improvements in the ConRail Philadelphia office. His projects involve, but don't benefit, ConRail, e.g. highway bridges over, or tunnels under, the tracks. (Daughter) Judy is still director of research and information resources for the National Association for Law Placement in Washington, D.C. Each of the latter has a son, 6 and 5 respectively. Bruce is still single."

MIT has announced that Professor Olivier Blanchard of the Department of Economics has been appointed to the Class of 1941 Professorship for a five-year renewable term, commencing September 1, 1994. He replaces Professor Paul R. Krugman, who left MIT for a similar position at Stanford University.

Professor Blanchard, who earned a PhD from MIT in 1977, taught at Harvard University before joining the MIT faculty in 1983. His field is macroeconomics and his recent work has concentrated on the transition of the former Soviet bloc economies of central and eastern Europe. He is the author of eight books, the most recent being *Transition in Eastern Europe*. Professor Blanchard employs natives of these countries as assistants in his work and wrote to Sepp that our class will be instrumental in foreign direct investment in this area. The class looks forward to enjoying our association with him, and hearing more about his important work.

Let's hope the mail bag is a little fatter for the next issue. You can help by sending in appropriate clippings, as well as personal accounts and pictures of your activities.—**Charles H. King, Jr.**, secretary, 7509 Sebago Road, Bethesda, MD, 20817-4839

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Harold G. Elrod, Course IX, received the Mayo D. Hersey award of the ASME at its recent conference in Maui, Hawaii. The award was for "fundamental contributions to hydrodynamic lubrication theory and for efforts that have led directly to improved bearing performance, modeling, and design." He also gets our own award for locating the most pleasant place for receiving the award!

Best wishes to long time class secretary **Lou Rosenblum** and wife Sandy on the October marriage of son Bruce to Irina Golfman. The ceremony was held at Sandy and Lou's home in Belmont, Mass.

Al Dengler passed away in August at his home in Weston, Mass. He served in Army Intelligence in the 90th Infantry Division in Europe. While in the Army, Al attended King's College in Cambridge. He owned a coatings and adhesives business in Framingham, Mass. Our sympathies to wife Marijeanne and to the family.—**Ken Rosett**, secretary, Apt. 12, 2222 Americus Blvd., N., Clearwater, FL 34623

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Susan and I are back from a 45-day tour of eight European countries, beginning with a flight on the Concorde and ending with a return voyage on the *QE2*. Included were the Normandy beaches, several Bulge battle sites, the Bridge Too Far at Arnhem, and the towers of the Ludendorf Bridge at Remagen on the Rhine. All very stirring. Wearing the MIT windbreaker received at the 50th Reunion brought me in contact with two other alumni: fellow tour member Roger Griffin, '54, and (on a Swiss railway platform) Walter H. Stockmayer, '35, professor emeritus of chemistry at Dartmouth.

I have received via the Alumni/ae Association a copy of a letter from **Mort Goodfriend** to **Cy Kano** (I think), dated 1993, reporting the death of **Gus Calleja** in Venezuela in January 1993. Gus suffered from multiple sclerosis. Mort recognized Gus with his wife and infant son in a 15-year reunion photo displayed at the 50th.

A note from **Alvin H. Shairman** (Course II), Worcester, Mass., says he has been conducting a modest consulting business since 1963. . . . **Harold J. Weiss** (also Course II) in Ballwin, Mo., sends an interesting story. Last May, somewhere between St. Louis and Stonington, Conn., he lost his MIT class ring. Being a wedding gift from Harold's wife, Janet, the ring had more than ordinary value for him, and he mourned its loss. Imagine his feelings when he received a call from a Ms. Annette Franklin at the Cracker Barrel in Effingham, Ill. His ring had been found, traced to him through the Alumni/ae Association, and would be returned forthwith. Harold now heartily endorses Ms. Franklin, as well as the Effingham Cracker Barrel. Says he, "The people there are very special and so is the food."

One-and-a-half news items plus a two-year-old obituary are a poor yield after a two-month absence. Surely you can do better.—**Bob Rorschach**, secretary, 2544 S. Norfolk, Tulsa, OK 74114-2624

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Following is the list of class officers elected for the next five years at the reunion in June: **Edwin G. Roos**, president; **James B. Angell, Lawrence C. Biedenharn, Jr., Langdon S. Flowers, C. William Ritterhoff, Paul K. Tchang, Edward B. Walker, III**, and **William A. Wynot**, vice-presidents; **Edgar P. Eaton, Jr.**, and **Stanley W. Warshaw**, honorary vice-presidents; **Frank K. Chin** and **Louis R. Demarkles**, co-secretaries; **Norman I. Sebell** and **Stanley W. Warshaw**, treasurers; and **E. Alfred Picardi**, class agent.

Several classmates have written expressing regret that they didn't send in a writeup of their experiences in World War II for the reunion book. We are certain that the class would like to hear about them. Please send your anecdotes to the secretaries. We will publish them from time to time here in the notes. They are a piece of history of a very famous class and should be recorded for posterity.

We are in need of news. Please send in items of your activities.—Co-secretaries: **Frank K. Chin**, 221 St. Paul St., Brookline, MA 02146; **Louis R. Demarkles**, 77 Circuit Ave., Hyannis, MA 02601

45 50th Reunion

Trust you caught that great picture of Katie and **Jake Freiberger** in the Nov/Dec issue of *Tech Review* as they properly promoted the benefits of a living trust. Trusts are an excellent way for all of us to celebrate the 50th Reunion and to contribute to our 1945

50th Reunion Gift. See **Jim Levitan** and his 50th Reunion Gift Committee for details—and this is not a paid commercial!

As your Reunion Committee diligently works on your 50th Yearbook, we unfortunately hear about all too many deaths. Violet Helve of Etowah, N.C., advises that her husband, **John Helve**, died April 25, 1994; no details. On October 10, Jeanne C. Hertig wrote **Bob Maglathlin** as follows: "**John [Hertig]** will not be attending the MIT '45 reunion as he had planned and was so looking forward to. John died on October 3, 1994, having been diagnosed with brain cancer some four weeks before. His physical deterioration was very rapid; fortunately, he retained his mental awareness to the end."

October 7, 1994, Trudy Ruehnmund called to advise that husband, **Max Ruehnmund** had succumbed to pneumonia on June 15, 1994. Max had been quite ill for the past four years and finally with cancer in the bladder. I must say that Trudy was on a high, not a low, as she talked about their 40 years of marriage and three children and five grandchildren all living close by on the eastern shore of Chesapeake Bay. Our deepest sympathy goes to the families of these three classmates.

Manual Cadenas of Coral Gable, Fla., wrote late last September to advise that he had retired from Metro Dade County as utilities manager after 13 years. Prior to working for the county, Manuel was with Uniroyal International for some 35 years, his last position as factory manager of a Mexican tire plant. . . . A brief note came from **Nick Mumford** complaining that Nynex telephone information service didn't give him our telephone number when he and Carol were visiting northern New England this summer. Now, if Nick had remembered the name of our town, he would not have had a problem! Oh well.

Fran and I have just returned earlier today from a visit to Black Point Inn in Prouts Neck, Maine, the off-campus site of our 50th Reunion. Believe me, Bob Maglathlin and **Charlie Patterson** made the correct recommendation. You will enjoy! Speaking of Bob, he advises that you can still make the 50th Yearbook if you forward your résumé, life history, or what have you to him promptly—I dare not describe "promptly."

The reunion, Technology Day, and V-12 Reunion programs have been cast—and you should be receiving much, much detail in the very near future. Please respond to us promptly as your classmates look forward to your participation.—**Clinton H. Springer**, secretary, Box 288, New Castle, NH 03854

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I received a letter from **James Craig** who notified me about the loss of one of our V-12 classmates, **Hillman Dickinson**. Clint Springer, '45 class secretary, sent in the following remembrance: "Lt. General Hillman Dickinson died of pancreatic cancer on September 2, 1994, at his home in Arlington, Va. Those who attended the 40th Reunion will remember meeting Hillman for the first time in many, many years. After all, Army duty has priority even over 1946 activities!

"Hillman, as you will all remember, was a most active undergraduate serving on the Institute Committee, Beaver Key, Q Club, plus many, many other associations and interests. Many of us have often wondered how he took three academic years of V-12 abuse, only to jump ship to start anew at the Military Academy in West Point, N.Y. Do you suppose he felt he would be a victim of mal de mer? Hillman was a B football player at the Point under the guidance and tutelage of Vince Lombardi of Fordham and Green Bay fame. In Vietnam, he served as a squadron commander in the 11th Armored Cavalry Regiment in 1967 and 1968, and was senior adviser to the South Vietnamese Army's 1st Division in 1971 and 1972.

"General Dickinson, who served in the Army for more than 30 years, spent much of his career in defense research and development. Over the years, he had been a manager with the Defense Department's Advanced Research Projects Agency and was the Defense Communications Planning Group's deputy director for engineering. From 1979 until retiring in 1982, he was director of command, control, and communications (C3) systems under the joint chiefs of staff. In this post, he worked to improve the survivability and reliability of communications systems. He had taught chemistry and physics at West Point from 1956 to 1960. In 1977, he was academic chairman of the West Point Study Group established after a 1976 Academy cheating incident. He wrote the group's final report. Survivors include his wife of 45 years, Nancy Cameron Dickinson, of Arlington; a daughter, a son, and a granddaughter."

Jim Craig went on a trip last June with his wife, Diane, to Dallas, Tex., to visit V-12 friend **Ed Hill** and his wife, Sharla. He learned from Ed how to contact **Warren Chapman** who lives in the Seattle area. Warren has retired from his medical practice and has a vacation place in British Columbia. Jim also went on an Elderhostel working cruise on an 127-ft. schooner around the San Juan Islands near Seattle. Jim attended the committee meeting for the 50th Reunion, which included **Glen Dorflinger** (Jim's old roommate), **Bob Hoffman, Herb Oedel, Ernie Buckman**, and the "regulars" **Ted Heuchling, John Gunnarson**, and **Ned Tebbetts**.

That's about all I can offer.—**Jim Ray**, secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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We just received notice that **John Holmes** died in July. He was living in Sun City, Ariz., and is survived by his wife, Ruhamah.

And that's *all* the news we have this month—we need some input from class members!—**R.E. (Bob) McBride**, secretary, 1511 E. Northcrest Dr., Highlands Ranch, CO 80126

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Bob Mott is still teaching math and helping with the administration of Kent School in Connecticut, but he is only working part time. He is also treasurer of his church, and says, "I am not overly busy, but I am not idle." He is enjoying partial retirement. Kent is doing well, and the school has moved the girls from a separate campus four miles away to one consolidated campus. Bob works with the Educational Council of MIT and meets with high school students who have applied for

admission. He enjoys contacts with mutual friends from the dorms who serve with him on the Council. Bob asks for news about **Roy Evans** and **Frank McGowan**.

Recently, **Jack Page** and his wife, Imogene, were drinking coffee from their 15th Reunion mugs, and Jack finds it hard to believe they've had the mugs over twice as long as he was out of Tech when they received the mugs. Last year Jack and Imogene sailed with friends on a bare boat charter out of Athens, Greece. They spent two weeks exploring the Greek Cyclades. The islands were interesting, charming, and restful. When they took the outboard-driven Zodiac to town from their mooring, they would leave it tied all day on the beach. When they returned, it was there, unmolested. Try that in the United States! They preferred this approach to a cruise ship, and they most enjoyed the islands not visited by cruise ships.

Jack attended the Alumni/ae Leadership Conference in September. **Denny McNear** was there, and Jack remarked to him that a lot had changed at Tech in the 46 years since we left, but not the weather. It rained buckets, and they were drowned rats by the time the conference, which was excellent, ended. Jack says he and Imogene think I am doing a supercalifragilisticexpialidocious job as class secretary.

Jim Adelstein continues his leadership role in the Harvard/MIT Division of Health Sciences and Technology. He also has responsibilities in the area of nuclear medicine in which he did some pioneering in past years. Recently he visited Tasmania and Australia. He suggested that Tasmania is the longest distance from Boston to another place. He visited with his son during the trip. In Sydney and Hobart he met with educators who are considering changes to make their programs more similar to the U.S. system of medical education. . . . **Harry Jones** continues his activities in mergers and acquisitions. He recently met with **Harold Ottobrini** to discuss some opportunities. Harry and his wife, Ann, live in Ridgewood, N.J., which is celebrating its 100th anniversary. Harry is treasurer of the centennial committee. Their son, Craig, was married last spring, and mom heaved a sigh of relief. Harry is Regional vice-chairman for MIT's Educational Council. He is active in recruiting alumni/ae to participate as educational counselors. Harry goes hiking every Tuesday with a group that walks seven to nine miles unless the temperature is below 10 degrees or it is raining hard. The area began mining iron in 1750 and until 1812 was the third highest producer using wood as fuel to process the ore. When coal took over as fuel, iron production moved away. The abandoned mines, villages, and artifacts make the hikes interesting.

Jerome Blackman is enjoying retirement from teaching math. His home is in Cicero, N.Y., but he spends half the year cruising the eastern Caribbean on his 45-foot ketch, *The Bonny Lass*.—**Marty Billett**, secretary, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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During the Alumni/ae Leadership Conference held at the Institute on September 24, 1994, **John W. Kunstadter** received the Bronze Beaver Award in recognition of distinguished service to the Institute. The Bronze Beaver is the highest honor the Alumni/ae Association can bestow upon any of its members.

Walter S. Cremens sent a cheery note announcing that, in an effort to uphold the reputation of the Institute, he has, at long last, been granted a patent on "Roll Consolidation of Thermoplastic Composite Laminates." However, an honor that pleases him more is his 1980 SAE Wright Brothers Medal for a paper called "Thermoplastic Molding Process for Aircraft Composite Structures." Feeling that every good Tech man should have at least one good book in him, he has bought a Macintosh and picked out a title: *They Call This Intelligence?* Look for it at your friendly bookstore.

I am saddened to report the death, on June 29, 1994, of **Isaac C. Foster**. Once again, I regret the lack of information on Mr. Foster. However, by looking in the 1989 MIT Alumni/ae Register, we learn that he was retired from W.R. Grace & Co., Cryovac Division, in Duncan, S.C. The class extends its condolences to his family.—**Fletcher Eaton**, secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50 45th Reunion

As the large type proclaims, we are the 45th Reunion class. Plan to spend the week beginning June 12 in Newport, R.I., with us.

George Krusen pointed out that the item about him in the August/September 1994 issue renamed him George Drusen. Sorry George. Here is another try. George Krusen continues to farm in Boxborough, Mass. Last winter

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(1993–94) his beehives perished. He had to buy at least one new one because he has arthritis sufferers who come to him for bee-sting therapy. (I am not making this up.) Bring some honey to our reunion, George; I am sure it will sell.

While in England I made contact with **John Mills**. John, who was raised in England, applied to MIT on the recommendation of friends and has never been sorry he took the advice. He returned to England and last June he retired from a career dealing in commercial diving equipment, which let him get to know **Sam Raymond** well. In October, John was planning to visit his sister in New Jersey for Thanksgiving and promised to consider returning next June for reunion.

While calling for the Alumni/ae Fund telethon I found **Rey Graunas** doing the same. He lives in Weston and retired four years ago after 40 years with GTE. There he worked with a variety of military hardware. He enjoys being a member of the Ancient and Honorable Order of Artillery Company, a male-only group that dates from the 1600s. Now they travel (stag, if you can believe it) to exotic places such as Thailand and Budapest. Rey is a former captain commanding of the group. Recently he went back to Budapest with Mrs. Graunas. I guess the place has its attractions. . . . I also got to talk to **Dick Stephan**, who retired from Arthur D. Little as a VP. He still consults part time for them in his specialty of energy economics. This work takes him to India and Pakistan. He claims he can get along in Urdu. Wow! What a provincial life I have led. . . . I talked to some other classmates but I must apologize because I misplaced my notes.

Last October the National Academy of Engineering inducted **Bob Pucel** for his contributions to semiconductor device theory, integrated circuit technology, and microwave system applications. Congratulations, Bob.

Joe Oppenheim writes from Satellite Beach, Fla., that he is auditing a course in civilization in the School of Psychology at Florida Institute of Technology. He plans to continue his work in psychology and English. Quite a change from Course VI, Joe. . . . **Bob Whitney** writes from Oakmont, Pa., that he spends his winters at "Top of the World" in Clearwater, Fla. (a good move, I'd say), where he studies philosophy. Bob also takes advantage of the cultural and sports opportunities in Clearwater.

There is some sad news this issue. **Don Ericson** died in November 1993. He was a combat infantryman in the Pacific before he came to MIT. In 1952 he helped found Pegasus Laboratories in Troy, Mich., where he was president for 15 years. He served on the board of directors of the Salvation Army.—**Robert A. Snedeker**, acting secretary, Seven Mashie Way, North Reading, MA 01864; **John T. McKenna**, secretary, P.O. Box 146, Cummaquid, MA 02637

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Slowing down on his consulting practice and increasing his entrepreneurial efforts in real estate, **William Lucas** writes from Beaumont, Tex., that he is still trying to learn to play golf. . . . After graduation, **Anthony Balzebre** did extensive South Florida and Gulf state development. He is now semi-retired, spending summer months in Hyannisport on Cape Cod, and enjoying his six children, their spouses, and seven grandchildren.

John J. Earshen has joined the firm of Angevine Acoustical Consultants, Inc., as vice-president. John is a Fellow of the Acoustical Society of America and a member of the American Industrial Hygiene Association. He had been head of the acoustic section of Bendix Systems and staff scientist at Cornell Aeronautical Laboratory. While chief scientist at Metrosonics, Inc., he participated in pioneering new sound measuring instruments using microcomputer technology. He is an adjunct faculty member at the University of Toronto and the State University of New York at Buffalo.—**Martin N. Greenfield**, secretary, 25 Darrell Dr., Randolph, MA 02368

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Please send notes for this column to: **Richard F. Lacey**, secretary, 2340 Cowper St., Palo Alto, CA 94301, e-mail<lacey@hpl.hp.com>

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Sorrowfully, I have very little news to pass on. (Lest you have forgotten or failed to read last month's unveiled threat, in so many words let me repeat it. If, starting on March 20, 1995, I do not receive sufficient notes and comments from you all to fill my monthly columns, then I shall resign. 'Nuff said.)

My penultimate news item: **Jack Walsh** sends the following note from his home in York, Pa.: "Continue fox hunting here and stag hunting in France. Have been called back to York International Corp. [his employer prior to retirement] as a consultant and will work 100 days per year. Sounds tough but I still have 60 percent of my time for investing, traveling, and riding to hounds."

My ultimate news item: Last Friday, Jane and **Gil Gardner** joined Kay (my wife) and I for cocktails and a viewing of our recent addition of a sunroom to our master bedroom. Afterwards, we shared a pleasant and leisurely dinner at a local steakhouse. Although Gil, Jane, Kay, and I are *all* retirees, only one of us—namely yours truly—really honors that *noble* status! That is, Gil is now spending some time consulting with his former firm (ANSWER), and Jane continues to serve as an HIV/AIDS instructor. My wife, only one day following her retirement from the U.S. Department of Energy, became a founder and partner in a new consulting firm. So much for retirement! It occurs to me that these "unretirement" decisions are admirable since, as a consequence, the marital partners do not always have to share lunch, as well as breakfast and dinner.

Do write and/or call me with news. The clock is ticking.—**Martin Wohl**, secretary, 4800 Randolph Dr., Annandale, VA 22003, (703) 354-1747

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Among the celebrants at the reunion last June was **Tom Henderson**, whose life has taken some interesting twists. He retired in April after 33 years with Guy F. Atkinson Co. out in California, but has continued his association with the firm on a part-time basis, as chairman of the board and director. In the meantime, he has been elected chairman of the board of trustees and acting president of the Pacific School of Religion in Berkeley. He is keeping busy. . . . **Dick Morley** showed up for at least one of the receptions at our reunion. He is currently in charge of R. Morley, Inc., in Milford, N.H. It is never really clear just what Dick does, but he keeps getting awards for his computer-related work and inventions, and is running a series of workshops/conferences on "New Technologies and Their Impact on Senior Executives" that began last November in Massachusetts and have continued in Chicago, Houston, and Dearborn, Mich., and will soon be held in Amsterdam and London. . . . **John Dixon** and **Harvey Steinberg** have been elected to the Council for the Arts at MIT. The council is a very active volunteer group of alumni/ae and friends established in 1972 to support the creative arts at MIT.

We are very sorry to have to report the deaths of two classmates. **Paul Goldin** died last May in New Jersey. He had taught statistics at Drexel University for 26 years when, in 1986, he and his son Ken opened The Score Board, Inc., in Cherry Hill, N.J. The company is considered the pioneer in specialized sports cards and memorabilia stores. It became the first such company to be publicly traded in 1987. Our sincere sympathy goes to Paul's wife, Carole, and their son and daughter. . . . **Gordon Smith** died in early August. He was the president and owner of Technical Managers Co., an electrical engineering consulting firm. He previously had taught at Northeastern University and had worked at Fenwal, Inc. Gordon had a number of inventions to his credit, and was a member of the team that designed the Eternal Flame for the John F. Kennedy Memorial. We extend sincere sympathy to his wife, Sybil, and their seven children.—**Edwin G. Eigel, Jr.**, secretary, 33 Pepperbush Lane, Fairfield, CT 06430

55 40th Reunion

Professor **Charles C. Ladd** has been selected to hold the second Edmund K. Turner Chair in the Department of Civil and Environmental Engineering. His honors include the Huber Civil Engineering Research Prize (1969) from the American Society of Civil Engineers, the Croes Medal (1973), the Norman Medal (1976), the Civil Engineering Department's Effective Teaching Award (1980), and the Hogentogler Award (1990) from the American Society of Testing Materials. He was elected a member of the National Academy of Engineering in 1983.

Have you noted June 14–18 on your calendar as yet? If not, do it *now* and join us for a memorable 40th Reunion.—Co-secretaries: **Roy M. Salzman**, 10643 Montrose Ave., 2A, Bethesda, MD 20814; **James H. Eacker**, 3619 Folly Quarter Rd., Ellicott City, MD 21042

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Robert Greene reports on his 34 years at the Pratt and Whitney Division of United Technologies Corp. He was part of the team that designed and developed products such as the Hydrogen/Oxygen fuel cell for the Apollo program and a liquid hydrogen rocket engine for the upper stages of the Saturn program. He also spent many years in the design, analysis, and development of gas turbine engines such as the JT8D (727, 737, and DC9), which is still in service and is the most produced engine in the world today with over 12,000 still flying.

In later years Robert worked in the areas of administration, staffing, and human resource management and contributed to the re-engineering and downsizing of Pratt and Whitney, and is still involved in these areas. Prior to the Pratt and Whitney experience, he spent two years at Kaiser Aluminum as a development engineer with the late **Art Hansen**.

Robert and his wife, Janine (Colby College), have a daughter and a son. Jennifer is working in a publishing firm in Boston; Derek is a junior at the University of Maine and has worked several summers at Philmont, the National Scout Ranch in Cimmaron, N.M. Since leaving Pratt and Whitney, Robert has been working on his home in Connecticut and vacation house on Kezar Lake in Lovell, Maine. He is also an avid amateur genealogist and has traced several branches of his family tree. In the summer he vacations in North Carolina with classmates **Dick Jacobs, Tom Hoffman, Harry Friedman,** and Art Hansen's widow, Pauline. Robert's at Internet: <75231.1152@compuserve.com>.

Send news to co-secretary, **Ralph A. Kohl,** 54 Bound Brook Rd., Newton, MA 02161; e-mail: <kohl@ll.mit.edu>

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Please send news for this column to:
John Christian, secretary
23 Fredana Rd.
Waban, MA 02168

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Belated notification has been received of the untimely death of **Phil Friend** and his wife, Judy, on March 24, 1994, in an automobile accident as they were returning to their Palo Alto, Calif., home. At the time of his death, Phil was corporate contracts manager for Sun Microsystems. He had joined Sun after selling his start-up operation, Tek/Link Corp. in 1987.

Phil was born in Bethesda, Md., received an SB in electrical engineering and went on to get an MBA from UCLA. Prior to founding his own firm he worked for TRW in Southern California and then as marketing director of Quantum Corp. in the Bay Area. Phil was active in alumni/ae affairs and had been elected president of the MIT Club of Northern California for the term beginning in the summer of 1994.

Phil and Judy were married in August 1993 and both had children from previous marriages. They are survived by Judy's children, Kelly and David Hails, and Phil's children, Robert, Marc, and Susan. Phil is also survived by a sister and brother. On behalf of his classmates we extend our sincere condolences to their families.

Please send news about yourself or classmates you are in touch with to **Gary Fallick,** secretary, 4 Diehl Rd., Lexington, MA 02173.

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A limited mailbox means limited notes this month, but here they are!

Martin Birnby writes that he is now retired and that daughter Debbie graduated in biology in 1991. He notes that at the 35th Reunion he really enjoyed seeing old friends who also came: **Ted Scott, Steve Denker, John Marko, Arthur Wasserman, Brad Bates,** plus some other course III classmates. A good reason to come to the reunions!

Another piece of reunion follow-up is the promised publication of our full list of class vice-presidents for the coming five years. They are: **Bruce Blomstom,** Los Angeles; **Bob Muh,** Northern California; **Shelly Razin,** Southern California; **Chuck Staples,** New England; **Alfredo Kniazzeh,** Boston; **Adul Pinsuvana,** Far East; **Marty Zimmerman,** Midwest; **Walt Humann,** Southwest; **Larry Boyd,** Pacific Northwest; **Dix Browder,** Wine Country (Sonoma); **Brad Bates,** Great Lakes; **Victor Mashaal,** French Canada; and **Larry Turner,** Ontario. As you can see, it's hard to go anywhere and not be in one of their territories. Congratulations to all, and I am sure our new president, **Jack Fischer,** will put this fanstasic capability to good use as time goes on.

Another event involving a number of our classmates was a mini-reunion in Taos, N.M., in August for the Phi Gamma Delta classes of '57, '58, and '59 (whose ages, interestingly, center around 59, 58, and 57). This was a weekend event, informally organized, and brought a total of 15 alumni and spouses to a beautiful part of the country. Most of the time was spent talking, sharing life experiences, and renewing MIT relationships (amazingly easy to do, even though some of us had not seen some there for 36 years!). In our class, attendees were **Joe Hudson, Al Beard, Larry Boyd, Bob Williamson, Al Kniazze,** and I. It was a wonderful, powerful, and fun time for all!

A sad note reports the death of **Basil Bonk** recently; it also notes that daughter Laura Bonk is a first-year grad student at the Institute.

That's all for now. Thanks to those who have contributed, and again I urge you to *actually do it*—to send an update which will be most appreciated by your classmates.—**Dave Packer,** secretary, 31 The Great Road, Bedford, MA 01730, (617) 275-4056

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35th Reunion

Richard Leonetti writes from Portland, Ore., that he has retired from the family furniture manufacturing business. Since then he has "climbed a mountain, tried paragliding, painted (watercolors), taught an occasional computer course (how-to-software) for some Oregon colleagues, and taught at an after-hours school for disadvantaged sixth and seventh graders." Richard also said that he has recently returned from an eight-week assignment in

Russia as a senior level advisor to a privatized furniture factory learning all about capitalism. Finally, Richard notes, "At my wife Shannon's prodding, I have become involved in public policy research and writing, and politics. Both are proving difficult areas to make things happen as I would like." And Richard says he has retired?

Dan Whitney took early retirement from Draper Laboratory in 1993 and rejoined MIT. He is associated with the Center for Technology, Policy and Industrial Development, where he continues his research on product development, CAD, and automation in the car and aircraft industries. . . . **Rick Hedrick** writes, "I recently changed my name by law to **Auran Justin Shagen**, but I will continue to use Rick H. for MIT/*Technology Review*. I am involved as a consultant in upcoming Mars exploration programs and a lunar update reconnaisance program having to do with return to Luna to inspect previous site/equipment. The technologies are related, and I will be recommending soft, self-healing gamma ray and micrometeoroid shields for long space contact." . . . A news item reports that **Frederick Rehhausser** has been named executive VP and COO of Ampro Computers, Inc., in Sunnyvale, Calif.

In the Oops! department: In the Nov/Dec '94 column I reported that **Mark Pratt** had joined Ceratherm Corp.; it should have been CeraMem Corp. Sorry for the error, Mark.

On October 31, 1994, yours truly completed a 34-plus year career with the Department of Defense and began a second career as a senior fellow with the Logistics Management Institute in McLean, Va. The work continues to keep me involved in defense matters, and the commute is about the same distance as the Pentagon but in the opposite direction. To celebrate the forthcoming changes in both our professional lives, Marie (who has accepted a position as special assistant to the president of American University) and I took a 15-day vacation to Greece. We had a great time on a trip that combined a cruise in the Aegean with travel to the Peloponnese and to Macedonia. Two downsides of the trip: we missed the wedding of Ellen and **Bob Gurnitz**'s daughter, Allison, and for the first time in history, the workers of Greece's Ministry of Culture went on strike and closed the Acropolis in Athens, denying Marie a chance to see some magnificent sights. I had been there before.

As you read this, planning for our class June get-together in Maine will have been completed. See you at our 35th!—**Frank A. Tapparo**, secretary and class agent, 15 S. Montague St., Arlington, VA 22204

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E-mail comes through again! **Simon Sarmiento**, who lives in England, sent the text of an article from a UK computer newspaper about his role as information systems manager at consultancy and systems house Logica. Simon can call on more than 2,000 internal specialists and has a staff of 40. In the article, he says, "We're moving to Windows NT and at present 75 percent of the people in Logica who know NT are working for me, on assignment....Universities are always Unix, Unix, Unix—they don't give much exposure to other things. Being an IT kindergarten for the high-flyers of the future brings its own problems....More time-consuming than running the business software is managing the network. This links 2,000 users working not only in a dozen Logica offices around the country but also at client sites." Simon writes that he is still married to Marilyn and has four grown children, two grandchildren (a third on the way). Thanks for the story, Simon.

Harry Baya sent a note saying that he is now at Hofstra University in Hempsted, Long Island, where he manages the student computer labs. As he still lives in Hastings-on-Hudson that means a pretty long commute! One of his sons just graduated from Antioch while the other is finishing up at Lynchburg University. **Martin Falxa** reports that last September *Scouting Magazine* had an article about Martin and his wife, Betty, in which they described the New England Orienteering training and championship program. . . . **Irwin Sobel** is back from a 1993 sabbatical in Pisa, Italy, where he worked on three-dimensional medical visualization for HP labs. The whole family became conversant in Italian, particularly his daughter Sarah who speaks paisano. Irwin has been at HP Palo Alto since back in 1983.

Dave Kresge is now senior VP, analytical services, at Dunn & Bradstreet's Information Services. Dave has had a distinguished career. After MIT he journeyed up Mass. Ave. and got a PhD in economics from Harvard. Harvard saw a good thing and took him on to the faculty. The government got a hold of him in the mid-60s and he was a senior economist for the U.S. Council of Economic Advisers. In 1981 he ended up at Dun & Bradstreet where he has been senior VP of a number of subdivisions. Congratulations, Dave!

I hope you all have a happy and healthy new year. Please keep writing and I'll keep everyone in touch.—**Andrew Braun**, secretary, 464 Heath St., Chestnut Hill, MA 02167, or via Internet: <andrewb820@aol.com> or <abraun@husc4.harvard.edu>

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The 1994 MIT Alumni/ae Leadership Conference in September featured **H. Richard Howland** as one of the recipients of the George B. Morgan Award given in recognition of sustained excellence in all aspects of MIT Educational Council activity. Dick received the award for his thoughtfulness and dedication as an Educational Counselor in and around the Pittsburgh, Pa., area. He has made special efforts to reach students residing in rural areas to ensure that they are included in the interview process for MIT admission. Dick annually opens his home to host a gathering of admitted students, and works to utilize the latest computer technology to improve communication between the Educational Council and its constituents. He also keeps in touch with MIT1962, and we appreciate his occasional comments.

Received a nice e-mail message from **Marty Klein** a while back. He is still active in the ocean engineering community, although it has been over five years since he sold Klein Associates. Marty has been actively raising bonsai trees and is VP of the American Bonsai Society. One of his flowering trees was recently featured on the cover of the *ABS Journal*. Even old techies can spread their wings from the bottom of the oceans to the arboretum in

the greenhouse. Marty ran into **Fran Berlandi** and his son at Macworld in Boston this past summer. Fran is a practicing attorney and has had some interesting cases that he discussed with Marty—now we wish he would contact us and tell us something about those cases for the column.

Don Horner is now employed by the (non-DOD funded) Ford Motor Co. in the Ford Electronics Division. He was doing intellectual property coordination (patent work) and is now graduating to technical planning and forum facilitation. He mentioned that Ford ELD has an excellent Patent Award Program that has provided more than 550 innovators with at least one patent each. He has been interested in the Ford management reorganization and notes that "management is being so careful not to disturb the working level's productivity during all of the organizational changes." Don is amused that his e-mail address is <usfmcq8p@ ibm.com>, due to the service being provided to Ford by IBM and their famous 8-character limit. He mentioned that it won't be long until it will be <dhorner@ ford.com>, a much friendlier address!

Ed Feustel sent me the news that **Charles Weller** hosted an MIT Class of 1962 micro-reunion in early September. Present were his wife; Elaine Ross, wife of **Jim Ross**; Ed and his wife; **Roger Sullivan**; and **Jim Ellis** and his wife and their two boys. Ed had not seen Jim in 30 years and was thrilled to renew old acquaintances. I assume from the guest list that this all took place in the Washington, D.C., area, probably at the Weller residence.

Alan Kotok enjoyed the last class notes via e-mail, and in response to my comment about "fire walls" he remarked that "Our (DEC's) fire walls are made from the same tiles as the space shuttle, and are virtually impenetrable!!" That's a pretty good trick on the Internet!

John Prussing liked my photograph in the November column, and was inspired to let us know that he has been selected to receive the 1994 Dirk Brouwer Award of the American Astronautical Society "for outstanding contributions to space flight mechanics and astrodynamics." John is off to the AAS Awards Banquet held in conjunction with the AAS National Conference and 41st Annual Meeting in Arlington, Va., on November 16, 1994, to collect his award. He noted that "one interesting aspect of the award is that the first recipient of the award, in 1972, was the late Theodore Edelbaum, his ScD thesis advisor, who then worked for Analytical Mechanics Associates in Cambridge. John thus claims to be a "second-generation" awardee. Dirk Brouwer, for whom the award is named, was on the astronomy faculty at Yale, director of the Yale Observatory, and co-author of the famous textbook *Celestial Mechanics*.

Ollie Smoot enjoyed the November column in *Technology Review* and is happy that I have been "flogging" the infamous "Smoot T-Shirts" [available from the MIT Museum gift shop and catalog]. He says that the reason they are economically priced is that he does not get a royalty on each T-shirt sold. Ollie is having an interesting time as chairman of the Information Infrastructure Standards Panel created by the American National Standards Institute to see what additional technical standards need to be developed, if any, to make the National Information Infrastructure (VP Al Gore's Information Superhighway) a reality. The committee hopes to include everyone from the Internet Engineering Task Force to the CableLabs, so it should be an interesting assignment. Now that Ollie is on the MIT1962 list, he will get the column even more efficiently, and before most of the news becomes a bit stale awaiting the printer and postal service's deft touches.

So if you have access to the Internet, please put a message through to: <MIT1962@mitv-ma.mit.edu>. Alternatively, you can send a message directly to me at: <uabhnm01@asncube.asc.edu>. And you, too, will get the (unedited and unexpurgated) class news while it is still fresh, hot off the Internet. But, even if you still communicate by traditional methods, please send your news and personal notes, via the USPS, to: Hank McCarl, secretary, P.O. Box 352, Birmingham, AL 35201-0352.

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Please send news for this column to: **Shoel M. Cohen**, secretary, Dept. of Psychology, Nassau Community College, Garden City, NY 11530 or e-mail: Internet <71271.2627@compuserve.com> or Compuserve <71271,2627> or home phone (516) 489-6465

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Bruce Strauss reports that he has reached another of life's milestones: he is a new grandfather thanks to his older daughter, Lori. Lori is an assistant professor of management at Purdue. Bruce is eagerly awaiting another exciting milestone: graduation of his last child from college. For the last several years, Bruce has been consulting ("selling his mind instead of his body"). His company is Cosine, Inc., based in Brookline, Mass., and he consults primarily in energy and other DOE areas.

Bob Bauman,OCE '72, SM '72, has completed a one-year assignment with the Washington Public Power Supply System, which operates the Washington Nuclear Plant (WNP-2), in Richland, Wash. Bob is returning to the Institute of Nuclear Power Operations (INPO) in Atlanta, Ga., where he has worked for 11 years as an evaluation team manager in various positions. While in Richland, Bob served as executive assistant to the CEO.

Glenn Slith has just completed 25 years with Amoco and 27 years with his wife, Suzan. Daughter Shannon begins a MSW program at Aurora University in Illinois in September, and daughter Heather is a music education senior at Indiana University.

My son, Scott, has joined Alpha Delta Phi at MIT, and so I am vicariously reliving freshman year.—**Bill Ribich**, secretary, 18 Revere St., Lexington, MA 02173, (617) 862-3617

65 30th Reunion

Marshall Fisher and **John Kassakian** were both inducted into the National Academy of Engineering in October. Marshall was selected for his work in solving large-scale engineering

problems in vehicle routing and logistics. He continues to teach at the University of Pennsylvania. John continues at MIT and was selected for his work in power electronics.

Ron Newbower held an outstanding conference in November: "Technology Payoff: When and How Will It Come to Healthcare?" I was pleased to attend and join in the discussions. Ron continues to be VP for R&D for Mass General Hospital.

I truly enjoyed the opportunity recently to visit the Canon Research Laboratory in Japan. **Hajime Mitarai** is now president of Canon and has moved to instill a strong belief in cooperation in the company. Their newest area of emphasis will be environmental and ecological technologies, not that they are foregoing their historic strengths.

Remember that the reunion is only a few months away! Write when you can.—**George McKinney**, secretary, 33 Old Orchard Rd., Chestnut Hill, MA 02167, (617) 232-4710; <gels@world.std.com>

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Because of the dearth of mail this month, I put out a message on our class listserv for news and was actually deluged (a deluge for this column is more than five pieces of mail). **Roland Pittman** celebrated 20 years at the Medical College of Virginia in Richmond, where he is now professor of physiology and biomedical engineering. He does research in cardiovascular physiology (oxygen transport in the microcirculation of muscle) when he isn't teaching the "wonders of the circulatory and respiratory systems" to his students. Roland just completed a term as president of the U.S. Microcirculatory Society. He has two daughters, Jennifer, a senior in architecture at Virginia Tech, and Katie, a freshman at Carnegie-Mellon in computer engineering.

Paul Kaminski, CEO of Technology Strategies and Alliances in Virginia, was elected to membership in the National Academy of Engineering for leadership and technical contributions to stealth technology and military systems. This is one of the highest professional distinctions an engineer can achieve. . . . **Jim Chinnis** runs a small, office-less consulting firm that deals in decision analysis, decision aids, and such. He had previously owned a similar larger firm but sold it and is now enjoying the technical side of the business rather than managing. He lives in Manassas, Va., on a small horse farm, where his wife, Lynn, rides while he works. Daughter Sarah has just started graduate work at American University in D.C.

Bert Forbes writes that his company, Ziatech, has grown to 80 employees and recently moved to a new 30,000-square-foot facility. His son, Bryn, is applying to—no, not another MIT dynasty—Harvard. Well, we do lose some. Bert noted that there are only five MIT alums in his area and we heard from one of them, too. **Martin Kaliski** is a professor in the EE Department at Cal Poly, San Luis Obispo, and also host of a weekly radio show on KVEC-AM called *Technology and You*. . . . On the other coast, **Fred Webb** is still at Bolt, Beranek, and Newman in Cambridge, working on TotalView, a debugger with features to support debugging parallel and distributed programming. He has three sons. His newlywed oldest son, Mike, graduated from Mass. College of Pharmacy and works as a pharmacist for CVS. Jeff is in college at Keene State in N.H. and Chris is a high school freshman. Fred's wife, Cindy, also works for CVS as a pharmacy technician.

Daniel P.B. Smith has moved from Intersystems Corp. to ECRM in Tewksbury, where he is working on software for their laser imagesetters. One of the fringe benefits he'll miss from his old job is the view of MIT from their offices at One Memorial Drive. Dan sings bass in the Baystatesmen Barbershop Chorus and founded a newsgroup, comp.lang.mumps. His children are in college, Josh at the University of Colorado in M.E. and Libby at UMass/Amherst. . . . **Michael Ward** is working on a new project at Adobe that involves an extension of the Acrobat technology, but that's all he can tell us right now. He can talk about his volunteer work helping the Study Centre for Early English Women Writers figure out how to digitize and OCR their collection of 16th- to 19th-century books. Mike also has a humorous article coming up in *Serials Librarian* on the future of serials in the era of intelligent agents. Keep that e-mail coming.—**Eleanore Klepser**, secretary, 84 Northledge Dr., Snyder, NY 14226-4056; e-mail: <vismit66@ubvms.cc.buffalo.edu>

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Please send news for this column to: **Sharlotte** and **Jim Swanson**, co-secretaries, 878 Hoffman Terrace, Los Altos, CA 94024, e-mail: <jswanson@lat.com>

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Please send news for this column to: **Gail** (ghm@nrc.gov) and **Mike** (nmarcus@fcc.gov) **Marcus**, secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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Where are y'all? I have not been receiving notes from you guys recently. I expected to be flooded with e-mail missives as soon as my electronic address was posted some moons ago.

We have news in note form from just one of you. **David Hill** writes from Chesterfield, Va., that he has changed jobs within Allied Signal. He's moved from being president of the Fibers Division in Virginia to president of Performance Materials in New Jersey. David said that he and his family were to be relocating to Mendham, N.J.

I have been having lots of e-mail exchange with classmate **Bill Lutts** of Irving, Tex., who appears to be quite an accomplished writer in his own right. Though he is not yet published, he's working on a book, the subject of which I'm not at liberty to discuss, but it *is* exciting—that's for sure! I expect we'll be hearing lots from Bill in years to come. His interests are at the frontiers of science, religion, archaeology, linguistics, and paleontology.

I also hear from time-to-time from **Ora Smith**—like Bill Lutts, another former Burton Fourther. Ora is president and CEO of Illinois Superconductor Corp. in Evanston, Ill., which is busy commercializing wild and wondrous things in high-temperature superconductivity.

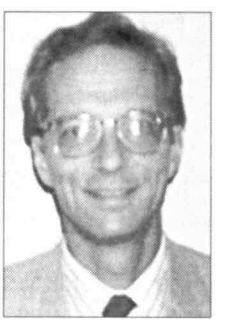
And not to forget my old aero-astro pal, **Jim Kornberg**, who is president of COHBI Corp. in Boulder, Colo. I get a call now and then from Jim who is successfully pioneering occupational health services and consulting for business and industry.

Don't forget, there is still time to get your tickets to Monte Carlo for the Fifth International Conference on Cold Fusion, April 9–13, 1995. Those of you who are fully electronic can reach me or submit class notes at Compuserve <76570,2270>. Via the Internet, use this form: <76570.2270@compuserve.com>.—**Eugene F. Mallove**, secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

ClassNotes

70 25th Reunion

Rick Boettger sent his first-ever submission to this column. He tells us that after completing a semester as a Fulbright professor in Moscow, he passed up tenure at the Texas Christian University business school to write popular books on the economy. In 1994, he published *The Deficit Lie: Exposing the Myth of the National Debt*. This year, he will be publishing *You're Fired! The Fed's War on Jobs, 1988–2002*. Rick and his wife, Michele, live mostly in Ft. Worth, but spend summers in California and winters in the Caribbean. Rick closes by echoing our sentiments: "I hope to see y'all at the reunion."—**Greg** and **Karen Arenson**, secretaries, 125 W. 76th St., Apt. 2A, New York, NY 10023



Rick Boettger

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Reunion News! Our class reunion is coming, soon. Your Planning Committee, **Zane Swanson, Dale Schain Krouse, Bob Schulte, Del Knarr** and me from our class, along with Joe Collins and Beth Garvin from the Alumni/ae Association, met by conference call. We need your participation and comments. First of all, we need suggestions for a class project. The front runner is an unnamed scholarship, but we would like your suggestions, too. We need volunteers for the Reunion Committee to plan a great class reunion that everyone will want to attend. If any of you have been motivated to give generously to MIT in the past, I would like to feature you in the class notes section to talk about your life and your motivation for giving to MIT.

It is my sad duty to report that **Martin Donovan, Jr.**, died August 28, 1994, in Boston. He was a senior computer systems analyst and

architect and was employed at CBS Imports and Wakefern Foods Corp. He was later employed as a project manager at Monchik-Weber on a joint project with IBM and Merrill Lynch of New York to replace their Quotron Network with an IBM Network. After many years he returned to Salem, Mass., and worked for Radio Shack and Computer Etcetera. He was a pianist and artist, performing at many school functions and recitals. He was also an avid mountain climber. He leaves his parents, Martin W. Donovan, Sr., and Dorothy, and a brother, Neil.

Ken Weisel writes: "In March 1994, I began work at the Missouri Joint Municipal Electric Utility Commission in Columbia, where I am general manager. MJMEUC is a joint-action agency providing services to 54 consumer-owned utilities. I like my job very much. While Lauren (age 4) visited Pat's family, Pat (Mills, '80) and I drove from California to Columbia. We left Roseville March 1, toured through and visited in Palm Springs, Joshua Tree National Park, Las Vegas, Grand Canyon, Painted Desert, Petrified Forest, etc., arriving in Columbia March 6. After this great trip Pat flew back to California to pick up Lauren, and they flew together to Missouri. The people in Columbia are very friendly and the pace of life is relaxed. Columbia consistently ranks in the top 20 of *Money Magazine*'s Best Places to Live. It's a college town (University of Missouri, Stephens College, Columbia College), so there's always something to do. It's halfway between St. Louis and Kansas City. Surrounding towns have lots of fairs and fests. We hope 1995 will bring you all the best. Friends, please keep in touch with us. Don't forget us here in Missouri! You can find us at: Ken, Pat and Lauren Weisel, 4311 Glen Eagle, Columbia, MO 65203, (314) 874-5603."—**R. Hal Moorman**, secretary, P.O. Box 1808, Brenham, TX 77834-1808

The Next Cartier?—This elegant Art Deco bank is the new venue for Silverscape Designs in Northhampton, Mass., where owner, gembroker, and jeweler Denis Perlman, '74, displays his work and that of over 300 jewelers.

Goldsmithing, as well as pottery, workworking, and leatherwork, were crafts Perlman brought with him when he enrolled at MIT. To earn money during his first term, he made a small investment in tools, silver, and tiger's eye gems from Boston's jewelry district, fashioned several rings in his room, and then sold them in Harvard Square. His success at this enterprise lured him away from the Institute and on the road in a schoolbus he fitted with a workshop. There he developed his craft and peddled his wares across country. Perlman returned to MIT and obtained a degree in molecular biology as a prelude to medical school. But after graduation he gravitated to Amherst, Mass., where he opened a cafe and sold his jewelry. Silverscape Designs evolved, and by 1991 it had received for the seventh consecutive time the *Valley Advocate*'s yearly award for "the best store of handcrafted jewelry."

The new store will expand into custom manufacturing, says Perlman, and he has hired three goldsmiths to assist him in his specialty: design. As Perlman points out, the value of jewelry has to do with the "symbols we carry in our minds." Some people are captivated by a particular gemstone—like the pianist for whom he designed a lavender moonstone ring that she could wear during perfomances; when she wanted a duplicate, he searched 12 years to find a similar stone. Others bring to him objects of personal meaning—a seashell, or a stone from a Himalayan village—for which he creates settings that suit the character of the wearer. "Whether they want to spend $5 on a little ring for a child or $20,000 on a ring for an anniversary, I want to help them," says Perlman. □

PHOTO: THE *HARTFORD COURANT*

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Please send news for this column to:
Dick Fletcher, co-secretary
135 West St.
Braintree, MA 02184

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A lone missive comes from **Dennis Tully**, now a Seattle resident: "Woodstock II stimulates memories of that first year at MIT—the strike, occupying the president's office, the Grateful Dead, all sorts of alternative educational experiments—a nice way for the Class of '73 to start college! Hello to old TEP/Commonwealth alums."

How interesting that as Dennis's note points out, things haven't changed in 25 years—protests against an unpopular president, troops overseas for who knows why, and OJ is in the news. The more things change, the more they stay the same. Write or e-mail!—**Robert M.O. Sutton, Sr.**, secretary, "Chapel Hill", 7721 Churchill Ct., Marshall, VA 22115, e-mail: <sutton_bob@prc.com>

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Having seen his name in print in the November/December issue of *Technology Review*, **Jens Eldrup-Jorgensen** called me last night to bring me up to date since I last saw him 15 years ago. Jens is a vascular surgeon, living in Cape Elizabeth near Portland, Maine. In his spare time he teaches at the Maine Medical Center that is affiliated with the University of Vermont Medical School. Jens and his wife, Barbara Hill, have a four-year-old daughter named Anna Hill Jorgensen.

Guy J. Consolmagno is the first one to submit his classnotes via e-mail. I hope others will follow his example. Guy entered the Society of the Jesuits six years ago. He is working as an astronomer at the Vatican Observatory, half time in Tucson (he has an office at Steward Observatory, University of Arizona) and half time at Castel Gandolfo, just south of Rome, Italy. Before joining the Jesuits, Guy was a Peace Corps volunteer in Africa and a professor at a small college in Pennsylvania. This past summer at the International Astronomical Union meeting in The Hague, during one of the Comet Crash sessions, Guy ran into fellow astronomer and new media star Heidi Hammel who immediately recognized him by exclaiming, "You were the rabbi in *Fiddler on the Roof!*" From a rabbi to a Jesuit, Guy's career transition is typical of many MIT graduates.

Denis Perlman settled in Amherst, Mass., after completing his third trip around the United States in a converted school bus turned mobile jewelry studio. In 1976, he opened Silverscape Designs and has grown 6,000 percent

since then. Last year his success enabled him to buy the huge architecturally significant Art Deco bank at the center of Northampton, Mass. It features the largest collection of handmade jewelry in New England, the work of over 300 goldsmiths. Denis invites his classmates to stop in any day to enjoy the gallery and the magnificent building graced by a nine-panel 30-foot high stained glass ceiling. His number is (413) 584-3324.

Bob Puckett and his wife, Gay, have a new baby, Robert Boyd Puckett, born on January 6, 1994. Bob works for IBM in Austin, Tex. . . . **Louis Gutentag** is now president of Technology Directions, Inc., in New York.—**Barry N. Nelson,** secretary, 65 Hillside Ave., West Newton, MA 02165-2543, (508) 663-7598 x1524, e-mail:<bnelson@cspi.com>

75 20th Reunion

Please send news for this column to: **Jennifer Gordon**, secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036 or 18 Montgomery Place, Brooklyn, NY 11215

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Send news, please. We can always use more!

From the mail: **Mike Royal** writes: "Moving to Tulsa, Okla., to start a pain management practice.". . . **Jonathan Weiss** writes: "I have been living in Russia for the past two years. Currently, I am in Rostov, a city of 1.2 million on the Don River. It is a beautiful part of the country, not far from the Black Sea and Caucasus Mountains, with warm weather and friendly people. I serve as advisor to the South Russia Privatization as part of a U.S.-funded program to promote economic reforms in Russia. Basically, my job involves organizing and providing technical assistance to private companies in areas such as business planning, financial accounting, preparing investment projects, and finding potential investors or business partners. I travel through three large regions that have diversified economies and have become involved in projects ranging from food processing to tourism to construction materials. Prior to this job, I spent a year and a half in Moscow, much of that time as a financial and management consultant on a World Bank project. At one point, I made an attempt to organize an MIT Club there, but after a year of trying, I had only found half a dozen alums besides myself. A few of us did manage one pleasant dinner together.

"On the personal front, I turned 40 earlier this year without much ado; I am still unmarried with no current plans to change that status but no objections in principle. Before moving to Russia, I lived in the Washington, D.C., area for 14 years; I still call it home and intend to return there someday. However, I really enjoy traveling, which has been one of the greatest benefits of my life as an expatriate. I have found time to revisit London, Paris, and Rome; and to travel to some new places, including Sicily, Estonia, Ukraine, and Turkmenistan. I expect to be here through mid-1996, so anyone headed this way, on business or for pleasure, is invited to contact me for whatever assistance or hospitality I can provide. The best way to reach me is e-mail: <jonathan@srpc.su>."

From our e-mail connections, news. **Barb Miller** writes: "I work three days a week as a system administrator for Eastman Kodak in Billerica, Mass., in the group that develops and tests software applications for Photo-CD.". . . **Rick Ottoline** writes: "I have been a geophysicist at this southern California oil company for four years now, after a long stint at Stanford/Silicon Valley.". . . **Dan** and Debbi (née Gross, '77) **Dershowitz** now live in Columbus, Ohio. Dan took a job with Ashland; Debbi may be starting her own consulting business.

David Shaver has sent us some unfortunate news, of which I would greatly appreciate some verification: "**Barry K. Dankovich** left MIT to pursue the priesthood. A few years later he was struck by a car and died." David heard this; if anyone has any further details, please e-mail your secretary. Thanks.

As for your secretary, he continues to plug along with his computer business and trading. Combining both with a family leaves less than an optimal amount of time for sleep!

Please remember to send news. E-mail is especially easy. Also, you can send in address changes or inquiries to: <mitalum@mitvmc.mit.edu>. —**Arthur J. Carp**, secretary, Quantalytics, Inc., 220 Henley Rd., Woodmere, NY 11598-2523; tel: (516) 295-3632; fax: (516) 295-3230; e-mail: <quantalyt@aol.com>

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Welcome classmates to the long-awaited Class of '77 column. Where are you guys?? Please write! . . . **Leo Harten** wants us to know that in addition to Paradigm Assoc., Inc., he has another time sink: CENTENET, Inc., which stands for Cambridge Entrepreneurial Network, an Internet service provider in eastern Massachusetts. Contact him for more info at <info@cent.net>. . . . A press release informs us that **Jill P. Kern** has been named treasurer of the American Society for Quality Control. Jill is a principal quality engineer with DEC in Hudson, Mass. Jill has served as a consultant for the Commonwealth Quality Improvement Council, supporting a team from the Massachusetts governor's office in total quality management implementation. She is also a member of the Society of Women Engineers and lives in Worcester.

A long letter arrived from **Steven J. Weissburg**, who is living in Cambridge: "I used to think that I myself was one of the most apathetic people in the world. However, now I realize that apathy is simply a side effect of having graduated from MIT in 1977. Ah, what pitiful correspondents we are! I am writing to let everyone know that Leo Gabriel Weissburg was born on June 10 [1994], through the major efforts of his mother, my lovely wife, Daria Donnelly (whose brother, **Chris Donnelly** is the godfather). As the grasshopper said to the blind, bearded man, '. . .now I understand.' Nothing matters now, as long as I get home from work in time to play with him. This June, as happens every June, I visited **Norm Smith**, his wife, Nadia, and two children, John Peter and Anna. Norm always takes in Rockport before the high season. Norm says that he doesn't like warm weather, but could it have something to do with the rental prices in July? Anyhow, it is always fun to wait, and wait, for the all-natural wood chip briquets to heat up the too small grill and then fight with Norm, his family, and the families of Chris Donnelly (aforementioned godfather, godmother Carolyn Bitetti, and godcousins) and **Phil Belanger** (no godrelation, Leona and Bernie). We always hope that **Jeff Lofton** will turn up, but he likes to visit Massachusetts when he can swim here.

"Chris is very busy with his small law firm litigation practice. Phil has just started an architect/engineer business in Lowell, and Norm is dispensing legal advice in Burlington, Vt. Just call him, he'll tell you all about it. I also enjoyed visiting with many MIT friends at the recent wedding of Dave Lee, '76, to Shiva Saboori (forever after, 'Lady Bride'). The ceremony was beautiful, at a lovely North Shore estate. Attending were **George Goodman** with his wife, Linda, and daughter, Amy; Alan Presser, '78, and wife, Dorothy Anderson; John Stahr, '78, and Jennifer Jonas, '78, with whom Leo spent Labor Day weekend. We see most of these people quite frequently, and it is nice to have that continuity in life. We also spent a lovely weekend with Professor Louis Menand counting mountain ranges. I have my own patent law business in Kendall Square, shouting distance from all of the intelligentsia around here. I enjoy it immensely. I spent many years among the biggest law firms in Boston. This is definitely better. Anyone is invited to drop in for a cup of coffee at the Au Bon Pain. We have plenty of room for visitors in our house in Cambridge also."

Thanks for a great letter, Steven. I can't promise everyone who writes that I will include their letter in its entirety, but if you include plenty of information about lots of classmates, I know we all would love the news! Our last tidbit is just that. We learn that **Steven F. Kaplan**, formerly executive VP of AM International, Inc., is now CFO for Marcam Corp. in Newton, Mass. . . . Let's hear from some of you non-Bay Staters! Write to me, **Ninamarie Maragioglio**, secretary, 9727 Stipp St., Burke, VA 22015

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Geoff Baskir writes, "We're gradually cleaning up and refurbishing our new house 'on land once owned by George Washington' (as was everything down there). Emma is now 18 months (and talking back). She spends her time entertaining the neighborhood kids and running off to the park. I've been with Parsons Brinckerhoff over four years already, working on the same two airports (Dulles and National), and doubtless I'll be at it for at least another year before I'm done." Geoff and family are living in Alexandria, Va.

A news release reports on **Peter Roemer**, who joined Advanced NMR Systems and its subsidiary Advanced Mammography Systems in June as corporate engineering managing director. He has authored or coauthored 25

ClassNotes

U.S. magnetic resonance imaging patents. Peter spent 10 years with General Electric prior to this move. The Roemers are relocating to the Wilmington, Mass., area.—**Jim Bidigare**, secretary, 9095 North St. Rd. NW, Newark, OH 43055-9538, (614) 745-2676; Fax: (614) 745-5648

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Bill Weihl and his wife, Lisa Mihaly, are enjoying their new daughter, Michela Klee Weihl (born October 9), as well as the accompanying sleepless nights. Bill has been a professor of computer science at MIT since 1984. He and his family are living in San Francisco until July 1995 while Bill is on sabbatical at Digital's Systems Research Center in Palo Alto. He writes, "I figure we'll catch up on our sleep when Michela turns 30 and finally gets her own apartment." . . . The Reverend **George Harper** and his family moved in November to the Philippines, where he is now a professor of church history at Alliance Biblical Seminary in Manila. George is the father of two daughters, ages nine and seven. . . . **Rick Meinig** practices orthopedic surgery in a six-person practice in Colorado Springs. He does research both in Colorado and in Davos, Switzerland. Rick and his wife, Katherine, a physical therapist, have a 6-year-old daughter and a 2-year-old son. . . . Your faithful secretary has changed companies and is working as a systems manager for yet another large Manhattan corporation. This place is crawling with MIT grads.—**Sharon Lowenheim**, secretary, 98-30 67 Avenue, Apt. 6E, Forest Hills, NY 11374

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15th Reunion

UPDATE: Just in from **Pamela (Hampton) Idriss**—it was reported in the November class notes that Pamela and her husband, Samir, left Boston in May to pursue Christian ministry. Well, turns out they never left. They are happy in their Victorian home, studying the scriptures and building their home businesses—BURNING BRUSH (graphic arts) and CANA CONNECTION (wedding consultant).

I received a long note from **Cindy Bedell** who is teaching engineering materials at the U.S. Military Academy at West Point. Although her focus is on teaching, she does some research on composites and smart materials when funding and equipment are available. Her husband, Mark Schmelz, '78, was planning to join the math department but Congressional mandates realigned the positions for which he was qualified, so now he is a house spouse keeping busy studying math and physics between loads of laundry. After hours Cindy coaches the Army Alpine Ski Team. Cindy and Mark spent June in Europe; in Florence, Cindy presented a paper at the 8th International Congress on Advanced Materials and Processing. You can reach Cindy and Mark via e-mail at <ic0269@trotter.usma.edu>.

David Isaacson just started a new job at GTECH in Rhode Island as a manager in product marketing. GTECH is the leading provider (70 percent of the market) of lottery systems worldwide. He will be helping to build the organization and expand their products. . . . **Mark Vershel** and his wife, Teri, announced the birth of their daughter, Rachel, on September 28, 1994. He writes from Palo Alto, Calif., that they are all learning how to exist with little sleep! . . . **John Mulligan** is now director of sequence analysis at Darwin Molecular Corp. in Bothell, Washington.

Save these dates—June 15–17, 1995—for our class reunion—BE THERE! Send your news to: **Kim Zaugg**, secretary, 549 Fairfield Rd., Canton, MI 48188, (313)981-1785; <vayda@erim.org>

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Please send news for this column to: **Mike Gerardi**, secretary, 3372 Olive St., Huntington Park, CA 90255, (213) 587-2929 (h), (310) 553-5050 (w)

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This month I received several notes via e-mail. Thanks for keeping all of us up to date!

Bill Nunan and **Eve Ahlers** welcomed their second child, Sammy, into the world in March 1994 on the San Diego Freeway on the way to the hospital. How's that for excitement! Mom, Sammy, and Dad are all doing fine. Their older son, Tommy, is now 3-plus years old. Eve is still working at TRW in Redondo Beach in the gas semiconductor fabrication lab. Bill is a month or two away from finishing a PhD in plasma physics.

Michelle Hunt successfully defended her dissertation at the end of July. She is entering her second year as an assistant professor at the Kenan-Flagler Business School at the University of North Carolina in Chapel Hill. She still loves it there, but the pressure has definitely increased. Now that the dissertation is done, the tenure clock is just tick, tick, ticking away. Her husband, Andrick Spicer (Virginia Tech Class of 1991), and she are more in love with their house every day and are really happy in Chapel Hill. Her e-mail address is <huntm.bsacd1@mhs.unc.edu>. She'd especially love to hear from any 4th Easters!

John Lucassen earned an EECS/LCS PhD in '87 from MIT. After graduate school he went to work at IBM's Japan Tokyo Scientific Center as a visiting scientist. In 1988 he went to work at McKinsey & Co. in Amsterdam and New York. Since 1990 he has been working at IBM's Thomas Watson Research Center in Yorktown Heights, N.Y., doing speech recognition research, product design, and marketing. Most recently he has been doing business process reengineering which I suppose he got a healthy dose of while at MIT since his undergraduate advisor was Professor Michael Hammer.

Lars Toomre was named managing director of MetLife Investment Management Corp. Lars will have responsibility for structured portfolio management and will head up MetLife's efforts in the areas of investment technology and product development as it relates to structured portfolios.

As for me, by the time you read this I will have had my second baby in December 1994. I'm still doing business consulting and education. We are soon launching an on-line network to offer discussions on advanced business topics and education in the areas of entrepreneurship, leadership, business design,

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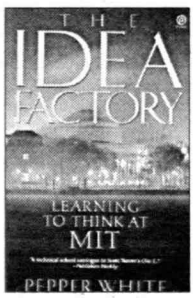

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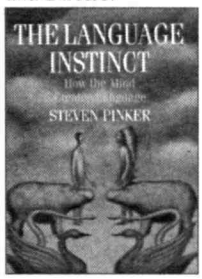

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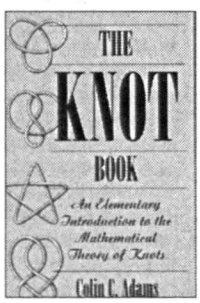
by Colin C. Adams, '78



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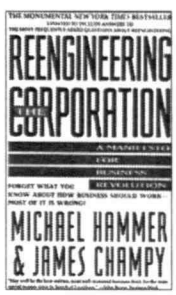

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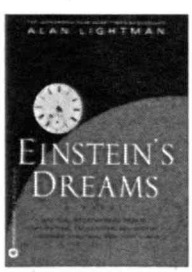
Professor of Science and Writing at MIT



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Puzzle

Continued from Page MIT 47

OCT 3. Winslow Hartford writes that his misspent youth at conventions infested with salesmen convinced him to write the following in a column about cancer clusters for the *Charlotte Observer*: "Dollar-bill poker": This is a friendly scam practiced at conventions. As there are eight numbers on the bill and 10 digits in all, you'd think multiple digits would be rare. But of 10 bills drawn from my wallet, nine showed "clusters" (two full-houses, four two-pair, three one-pair). (The "operator"of this scam, having changed a $50 bill in advance, is almost sure to have five of a kind). This report suggests a question for Puzzle Corner: How many random $1 bills does the operator need to:

a) have a 50% chance of 5 of a kind?

b) have a 90% chance of 5 of a kind?

It is not clear whether 6, 7, or 8 of a kind qualify as 5 of a kind. I believe the normal convention is that it does not, agreeing with Howard Stern's solution given below. If you wish them to qualify, change 9^3 to 10^3 in Stern's solution. Alan Shuchat made this assumption and, with the help of Mathematica obtained 161 and 533 as the answers to parts a and b. It does appear that changing a $50 bill does not ensure success. I can imagine that one might disallow 55555333 as five of a kind since it is some sort of super full house. However, I have not acted on that imagination. Here is Stern's solution:

First, determine the probability that a randomly drawn bill will show a 5 of a kind:

Since the two letters can never contribute to a five of a kind, their presence is irrelevant in determining the probability. The problem reduces to just looking at the 8 numbers. There are 10 digits possible (0 to 9) that can be used to form an 8-digit number. The total number of possibilities is the number of ways of arranging 10 distinct objects, 8 at a time, with repetitions allowed. This is:

$$10^8$$

There are 10 types of 5-of-a-kind hands, corresponding to the 10 different digits. The remaining 9 digits can be arranged in 9^3 ways since 3 additional numbers are needed toorm an 8-digit number. However, there are

$$\binom{8}{5}$$

ways to arrange each type of 5-of-a-kind hand. Multiplying out gives:

$$10\binom{8}{5}9^3 = 408,240$$

total ways to get a 5-of-a-kind hand. The probability of a 5 of a kind is:

$$\frac{10\binom{8}{5}9^3}{10^8} \approx .00408$$

To find out how many bills are needed to have (at least one) 5 of a kind with probability, p, reason as follows: The probability of not having a 5 of a kind is $(1-.00408)^N$. Therefore, the probability of N bills having at least one 5 of a kind is $1-(1-.00408)^N$.

If p=50%, then N≥170. If p=90%, then N≥563.

Better Late Than Never

M/J 1. Dudley Church and Jorgen Harmse note that South must hold the diamond jack.

M/J 3. Charles Wampler writes "The 'trepidation' you mention in publishing the solution to M/J 3 is well-founded, as I imagine you are going to get a few comments on this one!" Indeed, I did. Due to space limitations, details will appear in the next issue.

Other Responders

Responses have also been received from J. Chandler, T. Chase, R. Eiss, M. Fountain, D. Goldfarb, D. Goldman, J. Grossman, T. Harriman, W. Hartford, R. Hess, A. Katzenstein, A. Ornstein, D. Rosato, D. Savage, L. Schaider, R. Seaforth, and I. Shalom.

Proposer's Solution to Speed Problem

Q. These are the only capital letters with closed loops. BARBARA.

and management. Thanks for the notes.—**Helen Fanucci**, secretary, 502 Valley Forge Way, Campbell, CA 95008, e-mail:<FanGroup@aol.com>

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The following information comes out of the Space Systems Lab at the University of Maryland: Susan and **John Piotti** are the proud parents of Anna Piotti, born in August 1994, their first. . . . **Robert Kline-Schoder** recently moved from Palo Alto to Norwich, Vt. . . . **Charlie Lamb** and **Linda Lee** are living in Lexington, Mass. . . . **Howard Colodny** is in Amsterdam. . . . **Walter K. Daniel** is in Bowie, Md., working for ITHACO Space Systems.

Michael Santullo and his company, Sled Corp., have introduced a new Internet service that allows people, including classmates, to find Internet addresses for people they are trying to correspond with. The service is free and you can find out more about it by e-mailing Mike at <santullo@sled.com> or <http://www.four11.com>. The Four11 service already has 500,000 Internet addresses listed. You can search for people by a variety of criteria and can even get public keys to send confidential messages.

James F. Kirk is in Newberry, Fla., where he writes that he is on the home stretch, finishing up a PhD in materials science at the University of Florida. James notes that by this time next year he hopes to be a productive member of society once again. . . . **Dan Schwin**'s company, Shiva Corp., is going public. The company, based in Burlington, Mass., filed a 2.1 million share offering through Goldman Sachs and Cowen & Co. By the time this is printed, you can look the stock up on NASDAQ with the symbol SHVA. . . . **Matt Haggerty**'s company, Product Genesis, was recently featured in the *Boston Herald* (and you thought Matt's publicist only had an "in" with your class secretary). Product Genesis, based in Cambridge, Mass., now employs 40 people and is up to $5 million in annual sales.

Please keep those cards and letters coming.—**Jonathan M. Goldstein**, secretary, c/o TA Associates, High Street Tower, 125 High St., Suite 2500, Boston, MA 02110, Fax: (617) 574-6728

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Just a quick update this month. **Suzanne Greene-Burcat** is now married (as you can tell from her new last name), living in San Jose, Calif., and a mother! "Hope everyone had fun at the reunion," she writes. "Sorry I had to miss it. I didn't make plans to go because I thought I'd be nine months pregnant. Instead I was home trying to figure out how to take care of a week-old baby! Bryan Abraham Burcat was born May 29, 1994. He is a beautiful and wonderful baby! (Really! I'm just saying it because it's true!)". . . **Marc DiNardo** married Elizabeth Thompson Drum this past August. The newlyweds are living in Wyncote, Pa. Marc works as an aeronautical engineer for Martin Marietta Corp.

Zahid Ansari has been promoted to VP for product engineering at Orbit Semiconductor in Sunnyvale, Calif. Zahid is responsible for all post-fabrication operations as well as support of Orbit's ENCORE! software. In the 12 months that he's been there, his responsibilities have grown by 300 percent. "This dramatic growth makes Orbit an exciting place to be," he says. Before joining Orbit in 1993, Zahid was an independent consultant for two years, an engineer working on GaAs PLDs at Triquint Semiconductor, and a designer of bipolar and CMOS programmable logic at Monolithic Memories.

Send me your news, classmates! No matter how mundane, trivial, shameful, outlandish, or downright embarrassing, I'll plaster these pages with it and make you famous for an instant. (Now who else can promise you that?)

This month's tag line is: I'm so glad we had this time together. We'll start the day tomorrow with a brand new...column!—**Jonathan Miller**, secretary, 78 Roosevelt Cir., Palo Alto, CA 94306; tel: (415) 494-7430; fax: (415) 813-1130; e-mail: <jonathan_miller@logitech.com>

85 10th Reunion

It is a light month for news. **Steve Soares** writes, "Kirsten Domingo, '90, and I attended the wedding of **Rich Higgins** and Karen Henderson on September 22. Other MIT '85s from Next House attending were **Walter Baker** (best man), **Eric Liebeler, Roy Wetherbee, Dan Boder** (ushers), **David Wu, Dave Trempel** and wife Debbie, Babak Ashrafi, '86 , **Jerry Knaublach** and wife Connie (hope I didn't forget anyone). Dave Trempel and his wife are expecting their second child. Dave Wu is back in Mas-

sachusetts, working for VideoGuide. Dan Boder is now Dr. Dan and is working in Florida. Kirsten and I have since moved into our house in Arlington, taking care of the final details for our upcoming wedding. Don't ever buy a house and plan a wedding at the same time!"

On October 8, the First Bi-annual MIT Swim Team Alumni/ae Swim Meet was held at the Alumni/ae Pool. About 20 alumni/ae showed up from classes 1970–1993. The alumni/ae and the current swim team were divided into two teams—The Caps and The Goggles. The Class of 1985 made the biggest splash with **Peter Hickman**, **Andrew Renshaw**, **Celia Lee**, **Katheryn Warren**, and yours truly attending. Andy and his wife, spectator Amy Austin, '87, attended despite the imminent arrival of first child, Megan Austin, who made her debut on October 19. (Megan was apparently observed making strange movements that looked suspiciously like the dolphin kick shortly after birth.) Some other attendees (apologies to those that I have forgotten) were Karen Klincewicz Gleason, '82, Bill Dawson, '82, Kjirste Carlson, '84, Jim Bandy, '93, Scott Doran, '84, Marcos Fernandes, '89, Joel Harris, '83, Jesse Heinz , '70, Paul Krause, '88, Jennifer Snyder, '90, Marc Wisnudel, '91, and last but certainly not least John Schmitz, '83, who interrupted his honeymoon in Vermont to swim. Many thanks especially to Karen Gleason and Bill Dawson, who did much of the organizing.

Send news to **Bill** "I-can-still-do-100-yards-freestyle-in-under-one-minute-without-throwing-up" **Messner**, secretary, 5927 Alder Street, Pittsburgh, PA 15232; tel: (412) 361-4180; e-mail: <bmessner@andrew.cmu.edu>, class listserver: <mit1985@mitvma.mit.edu>

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The mailbox in October was not very full, so this month's column is fairly short. C'mon folks with e-mail access—let's try making next month a little better!

Karla Johnson is back at MIT, and writes that she and **Fredrik Johnsson** have ended up back at the 'Tute—this time at Sloan rather than Course XVI. The work isn't that hard, but the volume is great. Evidently, they're enjoying lots of free lunches as corporations make their presentations on employment opportunities at their companies. Karla's looking forward to graduating in '96 and being in the Boston area for our class's 10-year reunion. Karla worked in controls at GE Aircraft Engines for six and a half of the last eight years, but also managed to take time off and spend a year and a half in Mongolia. Most recently she ran a nationwide program with the Ministry of Science and Education called the Summer English Olympics. It was a competition in English emphasizing speaking and listening skills. Traveling to the six cities in Mongolia where they had teachers was quite an adventure. "I highly recommend a visit there if you don't need many creature comforts."

Karla saw **Melizza Zygmunt** (**Ayuyao**) and her husband, Stan, '84, in late summer. Melizza is expecting their first child in December. They're doing well—both are working at Valporaiso University in Indiana. **Patty Murray**, **Mike Bates**, and Karla got together with a few others last month in Boston. Patty is getting ready for a quick trip to Ireland, and then contemplating a career change from civil engineering to working for the Peace Corps in water-related projects. Mike is still working on flight simulators and interviewing undergraduate candidates for MIT. In between trips to Mongolia, Karla also got together with **Bea Garcia** in LA. She's doing well at Hughes, and really enjoys her job. Thanks for all the great news.

Edison Wong let me know I got his e-mail address wrong in the last column. His correct address is: <warlord@u.washington.edu>. Edison, at the University of Washington/Seattle, will be finishing his training in physical medicine and rehabilitation in July '95 and relocating back to the Northeast. He's already doing the job hunt right. . . . **Rose Joseph** writes from Northwestern University in Illinois, where she's doing a post-doc. She'll be looking for a teaching position starting in the fall of '95. Rose was back in Massachusetts for the wedding of Betsy Parker, '87, in August, but never quite made it back to Cambridge. Betsy now is in Evanston, Ill., and teaches high school chemistry and physics. While at a conference in Dallas in late summer, Rose also saw classmate **Toi Beveridge**.

From San Pedro, Calif., **Vic Christensen** writes that he's been at LA Air Force Base since December 1993 as the chief of information systems in the "Brilliant Eyes" program office. Vic felt great to get OUT of Ohio ("Booooorrrring!"), where he was stationed for five and a half years. He likes the warm weather again, and recently got his open-water scuba certification. And he's been riding his bike on the beach (Torrance Beach to north of the Santa Monica Pier! About 60 miles). (Now that it's winter in Boston, that sounds mighty good to me). Vic also writes that **Bruce Kristal** (started '87, graduated '86) was out to visit in the summertime to check out USC as a possibility for continuing grad work. As of this writing, it's not clear where Bruce will end up.

Back here in Boston, I saw **Sharon Israel** and **Kim Hunter** in late September at MIT's annual Alumni/ae Leadership Conference. Sharon was up from Houston,Tex., where she is working as a patent lawyer, and Kim was down from New Hampshire, where she lives and works. I also heard from **Dennis Arnow**. Dennis was recently promoted at Intel in Santa Clara, and is enjoying his new responsibilities in a manufacturing management role. I'll keep printing all the news that's fit to print. Please keep those postcards, e-mail, etc., coming in to: — **Bill Hobbib**, secretary, 5 Cappy Cir., West Newton, MA 02165; <hobbib@cognex.com>

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Greetings! Our news this month starts with **Stacy Weinstein**, who was invited to spend part of the summer in Spain teaching orbital mechanics and mission planning at International Space University, held in Barcelona. She says she had a great time—the students worked and played hard (parties 'til 3 a.m. every night). Stacy took an extra two weeks off after she left Barcelona to travel around Europe. She took the "student" approach to the trip, sleeping on trains and in youth hostels as she toured through Geneva, Venice, Paris, Luxembourg, and London (where she was able to crash with Brian Fabes, '84). The highlight of her trip was biking through Luxembourg—though it rained half

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the time, having to work hard to get where she wanted to go put things in a different perspective. Biking also allowed her to interact with more local people—she explored a castle with a German girl, an ex-bike racer who showed her around with a native's point of view, and a guy who knows two of her friends from MIT (small world). Although Stacy was sorry to return home to California, she is hoping to return to Europe next summer.

Melissa Krawizcki Lewis and her husband, Matt, '86, were blessed with happy and healthy twin boys, born on May 10th, 1994. Joshua Roger was 7 pounds and 20 inches long, and Benjamin Joseph was 5 pounds 13 ounces and 19 7/8 inches long. (Here, Melissa admits as an aside that she was huge.) They are the sixth and seventh "purebred" Choral-laries that Matt and Melissa know of (I want to know if they cry in harmony).

Jason Reyes and his wife, Ali, bought a house in Sharon, Mass., this past August. Jason is now in his third and final year of law school at Boston University and is busy there preparing the first CD-ROM issue of the new technology law journal. Upon graduation, Jason plans to start working as an associate at the Boston patent law firm of Fish and Richardson, where he is currently working part-time while completing his degree.

Mark Foringer is due to graduate from the Air Force Institute of Technology with a master's in aeronautical engineering in December 1994. His next assignment is at Wright Labs (at Wright-Patterson Air Force Base) where he will be working in the propulsion directorate, specializing on the materials used to build jet engines.

Steve Berczuk is still at the MIT Center for Space Research, where he is working on the "X-Ray Timing Explorer" satellite, scheduled for launch in a year. Steve now has a UROP student working with him, and is starting to understand how difficult (and challenging) it can be to do a good job supervising.

When her son, Parker, became 2 1/2 months old, **Greer Tan Swiston** decided to return to her job at Fidelity, in the Management Research Group. Her job involves writing application software for Portfolio Managers. Greer and her husband, **Rob**, recently attended the wedding of Lisa Rockoff, '88, and Jame Hardaway, and got to see many MIT alumni/ae there. They have also heard that **Jay Cohan** is taking some time off from work to bike through Europe. On a recent trip to California (Parker's first plane ride!), Greer and Rob saw **Taoi Doan** (who, along with **Chris Young**, visited the Swistons in Boston in May) and **Sofia Merida** (who is still playing soccer and volleyball as well as working at JPL). Up in the Bay area, they stayed with **Stan Oda** and his fiancée, Gina, and got to see Scott Martin, '87 (who just started his own company, Turnstone Software). They of course also visited Greer's sister, Grace Tan-Wang, '86 and her family: husband Jeff, '86, and young daughter Kelly.

Briefly, we hear through the Alumni/ae Office that **Dean Sciacca** is starting his last year of the PhD program at Purdue University. He is hoping to move back east when he is

done some time next year.

That about does it for this month. Send all news to: **Jack Leifer**, secretary, 2908 Roses Run, Aiken, SC 29803; home tel: (803) 642-3900; fax: (803) 642-2700; e-mail: <leifer@ccwf.cc.utexas.edu>, <MIT1987@mitvma.mit.edu >

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Nancy Perugini married Dave Riggs on the edge of Candlewood Lake at the exact moment that the autumn foliage reached its peak. MIT alumni/ae present included Bob and **Sheila Neville Flory**, Dave, '87, and **Joycelyn Valderrama Koehler, Carla Kapikian,** and Andy Singer, '89. I was responsible for introducing the happy couple and was rewarded with the all important matron-of-honor role. The couple honeymooned at Hilton Head. . . . **Ira Haimowitz** received a PhD in computer science from MIT this year and has taken a job with General Electric R&D Center as an information scientist. Ira and his wife, Barbara, are living in Niskayuna, N.Y. . . . **Julie Levine Friedman** is in her third year of pathology residency. Julie has recently vacationed to New Mexico and Hawaii. . . . **Cheryl Sampson** was recently designated a Naval flight surgeon. . . . **Glen Slick** is now part of the "Microsoft Miracle" in Seattle. . . . **Mark "Magick" Hamon** has been a commercial brewer for the last three years and has opened a microbrewery in Rhode Island, a brewpub in downtown Providence. Mark is leaving the United States to open the first microbrewery in Israel. He is considering calling one of his beers "Nagilah Lager" so he can use the slogan, "Come on everybody, Have a Nagilah."

Ira Haimowitz

Marc Light and **Jill Gaulding** were married in August on Bainbridge Island, Wash., (near Seattle) at Jill's parents' house. Class of '88 attendees included **Larry Candell** with his wife, Amy, '87; **Alec Jessiman** with his wife, Elaine; **Kamala (Sundarum) Grasso** with her husband, Paul; **Tom Stewart** with his wife, Susan, '87; **Geeta (Khare) Aggarwal** with her husband, Achal, '87; and **John Kim**. The ceremony took place in a church on Bainbridge Island. Three members of the class of '88 (Alec, Kamala, and Larry) were in the wedding party. Following the ceremony, the guests were led in parade formation (complete with bagpiper) to the Gaulding residence, where a beautiful reception was held. Marc is completing a PhD at the University of Rochester in computer science, and Jill is in her third year of law school at Cornell.

Marcia France completed a PhD in chemistry at Caltech in June and is now an assistant professor at Washington and Lee University located in Lexington, Va. Marcia is currently teaching organic chemistry (lecture and lab) and trying to get an undergraduate research program going. . . . **Mike Adelberg** has returned from London and is now working in LA. Mike is a mangement consultant and is looking forward to getting together with other MITers in southern California.

Julie Theriot received the "1994 Women in Cell Biology Award" from the American Society for Cell Biology (ASCB). Julie is a scientist at the Whitehead Institute for Biomedical Research in Cambridge. The national award is given annually to "a woman at the beginning stages of her career who has demonstrated potential for outstanding scientific contribution in her field." Julie completed a PhD in cell biology at the University of California/San Francisco and was selected to participate in the Whitehead Fellows Program.

The following news items have come thanks to the reporting efforts of Toby Sanders, '90, gathered during her travels last summer, via class of '90 secretary Ning Peng: **Joe Rondinella** is trading swaps for Sumitomo Bank. He has temporarily moved to London, for the past four years, where he is trying to lose his Brooklyn accent. . . . **Mark Longtin** also deals in swaps (for Merrill Lynch). Mark is frantically planning his October wedding to Lena Hsu, SM '92. Lena works with mortgage-backed securities for Prudential Securities. Lena and Mark just bought a condo in New York City. . . . **Tareq Hoque**, also in the financial industry, is engaged to Laura Weldon. (They met at a LIP-NOSE party four years ago.) They are getting married Thanksgiving weekend in Hawaii. Tareq works in emerging market derivatives for CS First Boston, while Laura is doing a surgery residency at St. Vincent's Hospital in New York City. . . . **Steve "Benny" Stein** is doing an anesthesiology residency at Columbia University. . . . **Perry Ziff** is living in New York City and working as a consultant for McKinsey. . . . **Larry Claman** and his wife, Susan, just celebrated their first anniversary. Larry works for the Information and Technology Group, also at McKinsey, although in Cambridge. Susan is a full-time master's student in Boston University's education program. . . . **Cathy Sybert Olkin** and husband **Terry Olkin** also just celebrated an anniversary, their second. Cathy is chasing occultations around the globe as part of her research for a PhD in Course XII. Terry, meanwhile, is working for a start-up company called Open Horizon in San Francisco. . . . **Andy Brockman** just got engaged to Elizabeth Nadworny whom he met through Laura Fleming, '90. Andy works for Lotus's ccMail division. Elizabeth (Liz) works for Stryker Endoscopy as a manufacturing engineer making endoscopes and arthroscopes, so all the doctors we have listed will have toys to play with.

Michael "Chez" Cohen lives in Bloomfield, N.J., and works for Garmen Associates doing transportation planning. . . . **Denis Gulsen** works for a start-up company called Chromatic Research where he is developing a "secret" operating system. His housemate, **Chris Racicot** is still working at Oracle. . . . **Scott Lordi** is plugging away at a physics PhD at the University of Illinois. . . . **Brad Fenton** is finishing his last year at Boston University's MD/PhD program. He just handed in his thesis and is currently doing neuroradiology research at the University of Washington. His wife, Cydney, is finishing pediatrics at Medigan army medical center. They are living in the Seattle area with their 2-year-old daughter, Victoria. For their next move they are hoping the Army sends Cydney to Ft. Bragg and for Brad to match in radiology or surgery in the Duke-UNC area. (If anyone lives out there, Brad would like to hear how you like it.)—**Catherine Suriano Singer**, secretary, 131 Main St., Andover, MA 01810; <singer@mit.edu>

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Greetings, the news is very, very thin this month, so I hope more people will pick up those pens or oil up their keyboards and send news.

This month's list of people to please send news is: **Mary-Jo Brigante, Richard Elder, Illy King, Alan Osterkil, Eric Shykan,** and **Karen Yu**. What are y'all up to? If anyone knows about any of these people or anyone else, please write in.

I am saddened to report that **Scott A. Weir** of Canton, a former naval officer and candidate for a master's degree in business administration at Indiana University, died of cancer Saturday, October 2nd, in Massachusetts General Hospital. Scott graduated from Canton High School, where he was a member of the math team that won the New England championship three consecutive years. After graduation in 1989, he served in the Navy for four years as a lieutenant aboard the guided missile cruiser *William H. Standley*, before entering Indiana University. He leaves his parents, William E. and Elaine M. (Pegolizzi) of Canton; and a brother, Brian E., also of Canton.

We can now all call **Vivian Liu** "Dr.," as she has recently graduated from Harvard. Vivian "gave an hour long seminar, and then was grilled for two and a half hours! I had three examiners who were all young; this was the first time any of them had been on a thesis defense committee, so they all took it very seriously. They really had read every sentence, and we went through the thesis very critically!". . . **Tim Sulzbach** reports that he has been busy with work at IBM in Burlington, Vt. When they let him get away, Tim has been running triathalons all over the hemisphere. Tim and his fellow co-workers bugged the network administrators enough so that they finally allowed access to the World Wide Web. Of course, one of the first things that Tim did was to browse the MIT '89 Web server, where he looked at some of the reunion photos. . . . **Valerie Stark Nicotina** is living in Albany, N.Y., and working as a software engineering consultant. Valerie recently returned to work after the July 1 arrival of Colin Keith Nicotina (8 lbs 1 oz).

Cindy Wang retired as a floor tutor at MacGregor and is now living high above the Longwood Galleria Mall, where she can see into her lab group's conference room, which is in the adjacent building. . . . **Samuel Druker** and his wife, Anna Cinniger Druker, SM '91, are keeping busy: Sam can't seem to play enough volleyball, while Anna has taken up jewelry making. . . . **Marc Itzkowitz** is finally done with education, having just completed an MBA at the Stanford Graduate School of Business. He has joined the marketing department of Illustra Information Technologies, a software start-up specializing in object-relational database management systems. Mark and his wife, Julia Kossack, just celebrated their first anniversary.

Well, that's it again for this month. Please send in news! Photos for next year's calendar (we'll even accept GIF or any electronic file format for photos) would be great as well!—

ClassNotes

Henry Houh, secretary, 4 Ames St., Cambridge, MA 02142; phone: (617) 225-6680; fax: (617) 253-2673; e-mail: <hhh@mit.edu> or <henry_houh@mit.edu>, World Wide Web URL: <http://www.tns.lcs.mit.edu/mit89/>

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Elena Koutras is in the second year of an MBA program at SMU in Texas and is engaged to Mike McFann, a 1989 graduate of the University of Kansas. Elena and Mike met at SMU. Mike proposed to Elena in late June in their favorite restaurant, a local sushi bar. He had their sushi chef help him out by hiding the engagement ring under a beautiful shell on one of the platters. The wedding is set for May 27, 1995, one week after they graduate. . . . **Janet Fordunski Richard** married Phil Richard on July 9, 1994, in southern California. **Benny Weintraub**, who is doing graduate research in biology at UC/San Diego was one of the guests at the wedding. Other guests included **Kelly Cunningham** and Jacquelyn O'Bryan, '91. Kelly flew in from Boston, and Jacquelyn flew in from Hawaii, where she is working on an MBA at the University of Hawaii. Jacquelyn was the maid of honor and was also responsible for introducing Janet and Phil. Jacquelyn and Phil were teammates on a skydiving team that took first place in the 1992 Intermediate 8-way National Championships. Now Phil and Janet enjoy skydiving together. When Phil and Janet aren't jumping out of airplanes, they are both working as engineers. Phil is an electrical engineer for Rockwell, and Janet is a civil engineer for AGRA Earth and Environmental. At night Janet is working towards a master's degree in geotechnical engineering from California State Univeristy, Long Beach.

Three other weddings took place this summer. **Aras Suziedelis** was married in Toronto, Canada, and **Tim Townsend** was married in Michigan. . . . **John Mruz** was married to Christine Osvald last August 13 on Long Island. John is now in his second year at the Harvard Business School. Class of '90 alumni in attendance at the wedding include **John Ziegler**, who is an IC design engineer at Unitrode in Nashua, N.H.; **Michael Valdez**, **Curt Wu**, who is a mechanical and magnetics engineer at Field Effects in Acton, Mass.; and **Andy Nisbet**, who's working at Aerospace Corp. in Los Angeles. Other MIT alumni in attendance were Rick Kim, '88, Darius Sankey, '88, and Steve Emeott, '89.

Congratulations to **Alfredo Ortiz**, who is the proud father of a baby boy! . . . **Peggy Liu** left her job as product manager of Symantec C++ in March and is now product manager of Internet Chameleon at NetManage in Cupertino, Calif. NetManage is doing very well in this exciting new market and is the leader in Windows Internet interfaces. Before starting this job, Peggy spent some time relaxing in Arizona and New Mexico. She also traveled to India/Himalayas for a two-week trek with 25 Stanford business school graduates. Peggy has also been busy taking care of her Lhaso Apso/Pekinese named Baby. She's now looking around for a teacup poodle to keep him company during the day.

Michael Valdez is working in engineering and software development at Mak Technologies, Inc., in Cambridge, Mass. Mak Technologies specializes in networked virtual reality simulation software. . . . **Mickey Wurts** is a computer consultant. . . . **Ken Lu** just joined Insignia from Oracle and will be a test engineer. . . . **John Wang** is working at Apple, and **Mark Sexton** is still in Alaska finishing up his ROTC commitments.

Please send news to **Ning Peng**, secretary, 732 Bounty Dr., #3215, Foster City, CA 94404, (415) 578-0704

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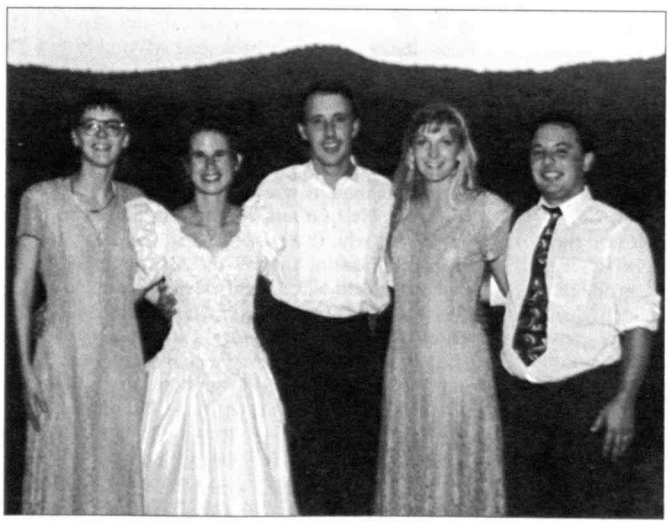
Although Valentine's Day is fast approaching, this issue's notes are coincidentally totally void of any wedding news. I guess that means two things: some very interesting things can happen to us even if we didn't just get married, and some of us single folk had better get busy! This month's notes are due in large part to the efforts of **Alex Min** and **Renee (Mong) Miller**, who have each spent untold hours gathering news from our classmates for publication over the last few years. Renee, list editor of '91 e-mail notes, sends her collection of news each issue. I encourage other classmates out there to take a few minutes to collect your knowledge about your friends and acquaintances, then send your news by postcard or letter to me, or by e-mail to Renee.

Alex has bought a house in Oceanside, Calif. He is a tactics operation officer at Camp Pendleton. His squadron was slated to be the first Marine Light Attack Helicopter Squadron to deploy to Kuwait, but when he wrote, Saddam had backed off, so Alex wasn't sure whether he'd go. Alex teases that "**Dave Haldemann** is still a 'non-flying object'or 'NFO' on P-3 Orions working out of Italy." Alex also reports that **Belinda Schmolke** is still working for IBM in South Africa. Alex has recently seen Mike Bradshaw, '92, who is a diver on a Navy salvage ship and was in port in San Diego, although his home base is in Hawaii. Alex attended a party at the home of Dale Hinman, '90, and saw Adam Taylor, '94, who attends UC/San Diego graduate school, Brian Browning, '94, Mike Ting, '92, and Dev Sinha, '93, who are all studying at Stanford.

As for Renee, she reports that her work life has calmed down a little since she does not have to travel quite so much (unless she is on vacation). Demonstrating the superiority of e-mail over "snail mail" (hint: if you have e-mail and two minutes, then dash off a note to Renee!), she reports much of the remaining news: **John Chen** is working on a PhD in materials science and engineering at MIT, and was a TA for Professor Thomas's 3.13 course. John has seen: **Dave Morrison**, who was in Boston for a computer security conference and is working at Oracle in California; **Dai Matsui**, who is in the public relations division of the Industrial Bank of Japan; and **C.Y. and Cynthia (Tee) Lee**, who were married last summer.

Lynore Abbott has started a new job in the "Holographic Products Division." Describing her research on holographic light management devices, Lynore writes, "Holograms have the unique ability to steer light in the direction that you want it to go using a minimum of space. So instead of a really fat glass lens, you can have a really skinny (6 micron) plastic hologram that does what you want it to do. It's been exciting to talk to customers who have been thinking about using holography for their products. Sometimes our customers have a whole lot more imagination than we do, so it's a great education for us to see how holography can help improve technology everywhere."

Jeff Evernham is engaged to Donna Bucci, (Penn State '93), who teaches junior high and high school mathematics and was an All-American lacrosse player. They met at church and will marry this summer. Jeff received a master's in aero/astro in 1992 and has since worked outside Philadelphia at Boeing



With the southern California hills as a backdrop, Janet Fordunski Richard, '90, and her new husband, Phil Richard (center), were joined by MIT friends (from left) Kelly Cunningham, '90, Jacquelyn O'Bryan, '91, and Benny Weintraub, '90, at their wedding.

Defense & Space Group, in the Helicopters Division. Jeff enjoys the Philadelphia area but has not found it to be the best locale for windsurfing. Jeff's first project at Boeing was on cockpit noise suppression for Boeing's tandem-rotor helicopter, then on the V-22 Osprey tilt rotor, and has since helped with the conceptual design of a civil tilt rotor device that, if successful, could alleviate airport congestion by making downtown-to-downtown commuting possible.

After graduation, **Malcolm CasSelle** went to Japan, where he worked in finance by day and as a disc jockey at night for over a year. He returned to the states and graduated from Stanford with a

master's degree in computer science. He is now working on launching a new magazine called *BLASTER*, which he describes in a recent article as "a print media solution for the expanding generation of young technophiles called 'screenagers.' *BLASTER* is about open minds, creative pursuits, entertainment, and technologies. . . . We will empower users with on-line services and steady incentives to make the magazine theirs." (For information on *BLASTER*, e-mail your query to <blaster@morph.com>.)

Since graduation, **Sandy (Owen) Schindler** has worked at Marcam Canada, a software company that was formerly called Shawware until it merged with Marcam, a Newton, Mass., company. In June, they released their first Object Technology product, which is the first group in a suite of Windows products designed to help manage large industrial sites, like mines or factories. She contributes new software architecture using C++, and enjoys using her new designs "for free." Married after graduation, she is now separated. She has recently taken up ice hockey and also keeps up with her field hockey play.

Mike Rizen stayed in Boston for a year after graduation to continue his thesis research, then enrolled in a National Institutes of Health sponsored Medical Scientist Training Program at the University of California at San Francisco, where he will earn both a PhD and MD. He has finished two years of medical school (and has delivered more than a dozen babies!) and is now in the graduate school program. He hopes to study the emerging gene therapy techniques for treating cancer. Mike enjoys life in San Francisco, especially tennis and pick-up soccer games in the Golden Gate Park, as well as the San Francisco Symphony. He has recently seen **Chris Houhoulis, Joe Heanue**, who is doing his graduate studies at Berkeley, and **John Heanue** and **Sae Woo Nam**, who are both doing graduate work at Stanford.

Other news for our column arrives by more conventional sources like our international network of class spies like yourselves. **Prabhat Mehta** graduated from Yale Law School and is now an attorney with Skadden, Arps, Slate, Meagher & Flom in Manhattan. Commenting on the recent bevy of news about classmates' weddings, **Lindasusan Ulrich** jokes that the reason she hasn't been in Class Notes for a while is that she hasn't been to a wedding recently. She reports that she enjoys devoting much of her life to the world of music. In the last three years, the UC/Berkeley Chamber Chorus, of which she is a member, has toured Germany and England and performed with the Philharmonic Baroque Orchestra and the Mark Morris dancers. She is also in an opera and has written 15 new songs this year that she hopes to record soon. She graduated from Berkeley with a master's in English and now much enjoys her job as a technical writer at EnergyLine Systems in Berkeley, Calif.

Please let us know what is new in your life, even if you haven't been to any weddings recently. Your news is what fills this column! Send your postcards to: **Andrew Strehle**, secretary, 59 Commonwealth Ave., Apt. 4R, Boston, MA 02116, (617) 450-0637, or your e-mail to: **Renee Miller**, line editor: <miller-rl@post7.laafb.af.mil>.

LINDASUSAN ULRICH, '91, IN CONCERT

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More news of all those MITers swarming the West Coast, especially California. Talked to **Helen Shaughnessy** a while back. She is living in Sunnyvale, Calif., and working for Raychem in the Chemalex Division along with **Rodrigo Rubiano** in the Polyswitch Division and **Matt Galla**, whom I would have guessed was off sailing the seven seas. . . . **Shari Schuchman** is working for Novelis in California. Helen offers her congratulations to **Suzy Ward**, who this past summer married Michael Rynerson, a fellow mechanical engineering grad student at MIT. Helen sends news of other transplants: **Heidi Gibson, Patrick Malone**, and **Lisa Arel** and her husband, Gary Hammer, are all in San Francisco. Sounds like a home away from home.

From halfway around the world, **Monte Frazier** writes: "I am having an absolute riot living and working at a Russian power plant on Sakhalin Island (on Russia's east coast, just north of Japan). . .certainly no creature comforts, but expat pay is cool and every day is a new adventure. . .sure is a long way from Course XVI!" Monte wears many hats, serving as the sole rep for the company. He is both the technical and political liaison to the Russian utility. They are in the planning stages of a project to increase the efficiency and availability of the plant in order to decrease the level of pollution.

Ellen Hornbeck was engaged to Jeffrey Sleight, a fellow physicist in graduate school at Yale. She is now managing a division at MicroPatent in East Haven, Conn. Prior to this, she received a master's in electrical engineering at Yale. . . . **Patrick Mo** is having a swell time in Chicago. . . . **Takiko May** was married to Jerry Sasser, '91, moved to Auburn, Ala., and is working towards a master's in English, concentration in creative writing. . . . **Joseph Stampleman** is at Apple Computer in Silicon Valley working on a set-top box, as well as other compression technologies.

Cameron Miner worked for the past two years on innovative medical products with the *Design News* "Engineer-of-the-Year," Dean Kamen, in Manchester, N.H. Now Cameron is working on a master's degree in Stanford's product design program. Any alums in the area (there are tons!) can contact him at <design-dude@aol.com>. Thanks, dude! . . . **Barrett Pappas** is in New York working in the Latin American Group at Goldman Sachs. Once in a while she sees **Josh Holden**, Scott Lawin, '93, TomJay Paul, '93, and Mercury Schroeppel, '94. After graduation Barrett worked for J&J in Puerto Rico, where she supervised 100 people in a manufacturing plant. Barrett also informs me that **Alison Williams** got married this past July. Congratulations to Alison. . . . Navy Ensign **Mark Bower** completed the Basic Surface Warfare Officer's Course this past summer. . . . **Marcus Darden** writes that he has completed a master's in mechanical engineering at UMichigan and is working on a master's in computer science.

Write some more. It's still me: **Leslie Barnett**, secretary, 56 Brown St., Mineola, NY 11501, (516) 746-4291

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Please send news for this column to:
Mari Madsen, secretary
12-16 Ellery St., #40,
Cambridge, MA 02138

CourseNews

CIVIL AND ENVIRONMENTAL ENGINEERING

From Springfield, Mo., **Saul A. Nuccitelli**, CE '60, sends word: "I am a practicing consulting engineer at Saul A. Nuccitelli, Inc., P.C., Cons. Engineers & Architects, the firm I organized in 1962. Our emphasis is on varied complex civil engineering, environmental, and architectural projects and we've been involved in forensic engineering for over 25 years. I am an organizer and on the board of directors at the Metropolitan National Bank in Springfield. I was formerly chairman of this city's board of city utilities, chairman of Springfield Special Benefit District, past president of Rotary Club International, Ozark Chapter-MSPE and Downtown Springfield Association, director for Bell Savings & Loan Association, assistant professor at the University of Denver and the Cooper Union, and a member of the teaching and research staff at MIT. I'm presently chairman of the Watershed Commission of the Ozarks, co-chairman of the Springfield Sanitary Services advisory council, board of directors of the YMCA, city utilities advisory council, and educational counselor for MIT. I was the recipient of a certificate of appreciation from the Missouri Municipal League in 1981 and I was named the Missouri Consulting Engineer of the Year in 1973. I've contributed to professional journals on strength of aluminum weldments under rapid temperature changes for the Titan missile, strengths of titanium, magnese alloys, and fiberglass for satellite construction, and strength of reinforced concrete columns under dynamic loading." . . . **Carl A. Gowan**, SM '76, writes: "I am a senior investment officer for real estate in the California State Teachers Retirement System since July 1993. I live in Marin County with Donna and we have four children, Dustin (13), Corrie (10), Jason (7), and Jennie (4). I became a member of the American Society of Real Estate Counselors in 1993." . . . **Brian J. Watt**, ScD '70, is living in Orange Park, Fla. He reports he is divorced and traveling around the world in a boat." . . . **Boris W. Boguslavsky**, ScD '38, sends word: "I gave a speech entitled 'The Excursion to the Seven Churches of the Apocalypse' to the Baton Rouge Genealogical and Historical Society on September 17." . . . Captain **Brian L. Baker**, SM '92 (I, XVII), reports: "I serve with the Corps of Engineers in Waltham, Mass., as environmental project manager. I work on several EPA Superfund sites in New England. I was recently selected for promotion to major." . . . **Avinash Singhal**, '62, SM '61, ScD '64, reports from Tempe, Ariz.: "I completed a one-year assignment as the director of the Central Building Research Institute in Roorkee, India. I was directly responsible for a new 'wood substitution' reserach program in India. I am now at Arizona State University as a professor of civil engineering in Phoenix." . . . From Lynnfield, Mass., **William F. Callahan**, SM '65, writes: "I was elected to the board of directors at Camp, Dresser, and McKee, Inc." . . . **Steven Harrod**, SM '91, writes from Needhan, Mass.: "I left the corporate world and started my own computer software and services company, SoftWerks. I provide services to small business, transportation, and engineering companies." . . . Major **Donald H. Horner, Jr.**, SM '85, sends this update from Fort Leavenworth, Kans.: "After I received a PhD in 1992 from Stanford in sociology, I served as assistant professor of sociology at the U.S. Military Academy at West Point for two years. I spent 1994 as a student at the U.S. Army Command and General Staff College." . . . **Elias B. Debbas**, SM '61, is manager of the civil engineering department at Hatch Associates in Iselin, N.J. . . . **Fred R. Harty, Jr.**, SM '62, lives in Marshfield, Mass., and serves as a consultant in hydroelectric power and pumped storage. . . **John M. Ting**, ScD '81, has been named a full professor at the University of Massachusetts/Lowell. Before joining the faculty of the Department of Civil Engineering in the College of Engineering at UMass/Lowell in 1990, Ting was a research fellow and lecturer at the California Institute of Technology and an associate professor of civil engineering at the University of Toronto. He researches and teaches computer modeling of large deformation behavior of single and multiphase granular materials with applications in foundation, earthquake, and cold regions engineering and materials processing. . . . **Erik Vanmarcke**, PhD '70, professor of civil engineering and operations research at Princeton University, was recently named Distinguished Alumnus for 1994 by the College of Engineering of the University of Delaware, where he received a master's degree. The award is presented to alumni/ae who have contributed or brought honor to the university through outstanding professional accomplishments. Vanmarcke was on the Course I faculty from 1970 to 1985. . . .

John Ting

Jonathan Richmond & Ethel

Jonathan Richmond, SM '81 (XI), PhD '91, sends e-mail: "Other alumni may have marriages, promotions, and Nobel Prizes to report, but I'm equally proud of the performance of my rubber duck, Ethel, third-prize winner in the annual Yukon River Rubber Duck Race in Whitehorse, Yukon Territory. Out of thousands of ducks hurtled riverwards by helicopter in celebration of Canada Day, Ethel showed her true MIT spirit by calculating the shortest path from touching-down on the river to the downstream finish, bringing her happy owner $1,000 in cash. Her third rather than first place can be attributed to sleep deprivation from staying up the night

DEGREE CODES

AE	Aeronautical Engineer
BE	Building Engineer
CE	Civil Engineer
CHE	Chemical Engineer
CSE	Computer Science Engineer
DPH	Doctor of Public Health
EAA	Aeronautical & Astronautical Engineer
EE	Electrical Engineer
EGD	Doctor of Engineering
ENE	Environmental Engineer
MAA	Master in Architecture Advanced Studies
MAE	Materials Engineer
MAR	Master in Architecture
MCP	Master in City Planning
ME	Mechanical Engineer
MET	Meteorologist
MIE	Mineral Engineer
MME	Marine Mechanical Engineer
MNG	Master in Engineering
MPH	Master in Public Health
MTE	Metallurgical Engineer
NA	Naval Architect
NE	Naval Engineer
NUE	Nuclear Engineer
OCE	Ocean Engineer
PhD	Doctor in Philosophy
ScD	Doctor of Science
SE	Sanitary Engineer
SM	Master of Science

before to solve the problem. In other news, since getting a PhD, I've spent time as transporation policy advisor to the chair of the Los Angeles County Transporation Policy Commission, and left my mark as a faculty member at UCLA: I made my first class assignment due on top of a mountain, knowing that although the class had a two-and-a-half-hour uphill sweat to deliver it, there was no threat of being awarded an Institute Screw! I'm now back in England as a lecturer in economics at the University of Reading. Any of you who happen through are very welcome to be in touch. Other highlights have been seeing dawn from the summit of Mt. Sinai, staying with Bedouin in Jordan's Wadi Rum desert, landing on an Alaskan glacier by helicopter, walking through Sydney's new Harbour road tunnel on opening day, touring the Toto toilet factory in Japan—one of the world's largest and grandest—(some of their handless flushing mechanisms are in use at MIT), and staying at the Ottawa Hostel—the former jail, kept in original condition."

Richmond continues: "Course I alums I have met while on the move include **Joel Freilich**, '80, now heading up the planning department at the Cleveland transist authority. While in Paris, I saw **Eric Peyrard**, SM '82, who works for Oracle. He and his wife, Margie, live in an elegant apartment and they are both amazing cooks—I'll be returning for seconds! **Sharon Bruce**, SM '82 (formerly Schur), and I both went to the London School of Economics as well as MIT, and had a craving to return to the womb—the LSE cafeteria, which makes Lobdell seem truly gourmet. The cardboard meat pie and slushy baked beans were as revolting as ever, but it was comforting to know they were still being served. Sharon now works at the Office of Population, Censuses, and Surveys. She commutes from Farnborough, where she lives with her husband, David. **Brendon Hemily**, SM '81, PhD '82, and **Eve Wyatt**, SM '80, have a cozy house in a nice part of Toronto and appreciate living north of the border—they are both working in transportation. **Poh Ser Hsu**, SM '82, PhD '85, lives in Cerritos, Calif. His house is dominated by the massive loudspeakers his nascent company proudly manufacures. He now has a wife, Lang, and a daughter, as well as the loudspeakers. **Rabi Mishalani**, SM '89, PhD '93, who is originally from Beirut, has finally ended his search for Boston's "Green Line" on discovering that it is not a "line" that connects rather than separates the city. Not all of those who suffer the T's inept service would agree. Rabi continues to work on transportation problems as a member of the research staff at MIT. **Scott Ramming**, PhD '94, is meanwhile doing transporation projects at Charles River Associate."

Navy Lieutenant Commander **F. Joseph Rubino**, SM '89, recently received a doctor of jurisprudence degree from the Temple University School of Law in Philadelphia. Rubino earned the degree through off-duty studies while assigned with Commander, Space and Naval Warfare Systems Command in Washington, D.C. Rubino joined the Navy in 1980. . . . The U.S. Commerce Department awarded its Silver Medal to **George F. Smith**, '73, and Donna I. Page of the National Oceanic and Atmospheric Administration's National Weather Service for outstanding work in revolutionizing operational river forecasting and flood warning by development and field implementation of the NWS River Forecasting System Interactive Forest Program. Smith, who serves as a research hydrologist in the Office of Hydrology, has been with the national Weather Service since 1975. The Silver Medal is the second highest honorary award granted by the Secretary for major contributions of exceptional value in support of the goals of the department and service to the nation.

The Province of Mendoza in Argentia has signed a five-year, $7.8 million contract with MIT for a program of education, research, and administative assistance to help establish a center of technology innovation. The effort will involve educational programs and joint research. Possible areas of interest include water resources, transportation and infrastructure, energy, environment, telecommunications, information technology, petrochemicals, and biotechnology in the province, which is 100 miles east of Santiago, Chile, over the Andes Mountains. The participation of MIT faculty and graduate students and colleagues at the Universidad Nacional de Cuyo in Mendoza is expected to accelerate the establishment of a center by local officials. **Rafael Bras**, '72, SM '74, ScD '75, head of Course I, and **Fred Moavenzadeh**, director of the Technology Development Program, will head the project for MIT as principal investigators. MIT will concentrate its efforts to develop advanced educational programs, research activities, and supplemental educational activities such as workshops, personnel exchanges, short courses, and fellowships. Mendoza Province has a population of more than one million. It is an area of 58,000 square miles, slightly smaller than New England.

Roger Foott, ScD '73, of Lafayette, Calif., died on October 4, 1994, after a long battle with cancer. He was president of his own company, Robert Foott Associates, a firm of geotechnical, geologic, and environmental engineers in San Francisco. . . . The Association of Alumni and Alumnae has been informed that **David Philip Hopkins**, SM '53, of Sacramento, Calif., died on December 19, 1993. There was no further information provided.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>**.

MECHANICAL ENGINEERING

M. Arshad Jilani, SM '75, sends word from Shanghai: "Last July, I was promoted to manager of technology programs at GE Jiabao Lighting Co., Inc. This is GE's first operating joint venture in China. The venture gives GE 60 percent ownership in a JV established in July 1994. With a $40 million investment by GE, this company makes 40 percent of China's incandescent lamps, with a small share of the fluourscent and HID market. My responsibility is to install capacity equipment and plants to provide GE Jiabao Lighting with a dominant share of the fluorescent market in China and to improve quality and share of HID Lamps." . . . Rear Admiral **Fred L. Ames**, SM '73, OCE '73 (XIII), reports: "I was promoted to my present rank in the U.S. Coast Guard on September 29, 1994. I am currently residing in Burke, Va., with my wife, Holly, and daughter, Caroline. I have assumed the duties of commander, Coast Guard Military Personnel Command." . . . Lieutenant **Douglas J. Hencke**, SM '92 (II, XIII), writes from South Weymouth, Mass.: "I've been chief engineer on the U.S. Coast Guard cutter *Campbell* since 1992. I've been heavily involved in recent Haitian and Cuban migrant rescues at sea and enforcement of fisheries laws and treaties in the North Atlantic." . . . **Stan Gershwin**, a Course II senior research assitant, sent us a copy of an advertisement for Toyota that ran in the *Japan Times* on August 29, 1994. In it Toyota uses **Chris Couch**, '93, SM '93, as an example of how Toyota maintains quality. The ad, which was accompanied by a photo of Couch surrounded by car intestines reads: "We hired him to tear us apart. He has a masters in engineering from MIT. To get it he studied production systems in all kinds of industries all over the world. From all he saw, he concluded that our production system was the best. So he came to Japan and knockedon our door. 'I'd like to work for you,' he said. 'I'd like to see what makes you so good.' He's down in Toyota City now, working with an engineering team that pulls brand new cars off our assembly lines, breaks them down, and finds ways to put them together cheaper, faster, easier. He's learning a lot from tearing us apart. He's starting to see in a different way. He's getting ideas. And giving us ideas, too. Christopher Couch, from Dallas Texas. Now that he

knows what makes us good, he's determined to make us better." . . . **Ibrahim (Abe) M. Elfadel,** SM '86, PhD '93, reports: "I am now a senior scientist with Masimo Corp., in Laguna Hills, Calif., a startup R&D company specializing in the licensing of new technologies in the area of non-invasive medical instrumentation." . . . Commander **Peter C. Filkins,** SM '91, NE '91 (XIII), writes: "My family and I have been transferred to Riyadh, Saudi Arabia, where I am serving as the deputy for engineering and maintenance in the U.S. Naval Forces Division in the U.S. Military Training Mission to the Kingdom of Saudi Arabia." . . . **Carl R. Peterson,** SM '58, ScD '63, reports: "I just completed a five-year term as chairman of the Committee on Review and Evaluation of the Army Chemical Disposal Program under the National Research Council for the U.S. Army." . . . Last May **George L. Niemeyer,** SM '62, assumed the position of VP for facilities management at Lewis University in Romeoville, Ill., after 24 years of airline industry work. . . . **Ioannis N. Miaoulis,** SM '84, has been named dean of the College of Engineering at Tufts University in Medford, Mass. . . . **Nicholas R. Tomassetti,** SM '58, has been named president and COO of Airbus Industries of North America, Inc. (AINA). Formerly VP and general manager of twin-jet business development for McDonnell Douglas Corp., Tomassetti is responsible for such AINA activites as sales, contracts, market planning, and sales finance for U.S. and Canadian customers. Prior to joining Douglas, Tomassetti was executive VP of Pratt & Whitney's Commercial Engine Business organization. During more than 30 years at Pratt & Whitney, Tomassetti held various positions in engineering, marketing, and customer support.

Navy Lieutenant Commander **Mary Townsend-Manning,** SM '87, NE '87 (XIII), recently reported for duty aboard the fleet ballistic missile submarine USS *Pennsylvania*, homeported in Kings Bay, Ga. Townsend-Manning joined the Navy in June 1979.

Four Course II alums received awards from the ASME last November. **Graham B. Wallis,** SM '59, the Sherman Fairchild Professor of Engineering at Dartmouth College in Hanover, N.H., received the Fluids Engineering Award for "extensive research in the field of two-phase flow and for writing on the extension of potential flow theory to two-phase flows." For 35 years, Wallis has developed expertise in multiphase flow. His work has ranged from fundamental theory to industrial applications. His book, *One Dimensional Two-Phase Flow*, is one of the few basic texts in the field that sets out a framework for the most common methods of analysis. Wallis has been on the faculty of the Thayer College of Engineering at Dartmouth since 1962 and served as associate dean from 1989 to 1993; he is currently interim dean. He has also been associated with Creare, Inc., an engineering consulting firm since 1963. **Avram Bar-Cohen,** '68, SM '68, PhD '71, professor and director of the thermodynamics and heat transfer division in the Department of Mechanical Engineering at the University of Minnesota at Minneapolis, has received the ASME Edwin F. Church Medal "in recognition of contributions to engineering education, continuing education, and professional development on both national and international levels as an organizer and lecturer of short courses on the forefront of technology, and significant contributions to the ASME board on professional development." For the past 25 years, Bar-Cohen has been involved in the design, analysis, and optimization of thermal systems, with emphasis on the thermal packaging of electronic equipment. In 1993 he was invited by the UN to lecture and consult to the electronics industry in India.

Kenneth Diller, ScD '72, the Harry L. Kent, Jr., professor of mechanical engineering and chairman of the Department of Mechanical Engineering at the University of Texas at Austin, has received the ASME Heat Transfer Memorial Award for Art for "innovative application of the principles of heat transfer to the field of biomedical engineering, including experiemental and analytical techniques for successful measurement of the properties of living cells at sub-zero temperatures and the transient thermal parameters in tissue burns." The primary areas of focus in Diller's research include the frozen banking of human tissues for transplantation, analysis of the microvascular basis of burn injury and how it may be exploited for the optimization of thermodynamic models of dynamic processes at the microscopic and macroscopic scales in biological systems, and computer vision techniques for quantitative measurement and interpretation of microscopic images. **Adrian Bejan,** '72, SM '72, PhD '75, the J.A. Jones professor of mechanical engineering in the Department of Mechanical Engineering and Materials Science at Duke University in Durham, N.C., has received the ASME Heat Transfer Memorial Award in Science for "significant and often unconventional contributions to heat transfer, notably in natural convection, thermodynamic aspects of heat transfer, convection in porous media, thermal tribology, solar energy conversion, cryogenics, and transition to turbulence; and for bringing modern research results and methods into heat transfer education." Bejan, who has written five textbooks and research monographs, has left his mark on the development of heat transfer, its methodology, and language. He pioneered the method of entropy generation minimization (or finite time thermodynamics), scale analysis, the visualization of convection using heatlines, and the buckling theory of turbulent flow. On two separate occasions, peers have given the Bejan number (Be) name to dimensionless groups in the field of heat transfer: the pressure drop number and the ratio of fluid friction irreversibility divided by heat transfer irreversibility.

The Association of Alumni and Alumnae has been notifed of the following deaths: **Devendra D. Mehta,** SM '68, or Windsor, Conn., on November 6, 1992, and **Bernhard Schondorff,** '37, of Erkelenz, Germany, in March 1991. No further details were provided.

CORRECTION: **Jens T. Jensen,** SM '83, was erroneously reported to be deceased in the November/December '94 issue of *Technology Review*. Jensen is alive and well and living in Hartland, Vt., with his wife, Catherine. Since graduation, he has worked for a series of startup firms in optics and medical imaging. He now works out of his home as an engineer consultant and continues to work part-time for his last employer, Dover Systems in Lebanon, N.H. A biker and a snowboarder, Jensen says he is enjoying country living.

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III MATERIALS SCIENCE AND ENGINEERING

George Krauss, SM '58, ScD '61, the John Henry Moore Professor at the Colorado School of Mines, writes: "I was awarded honorary membership in the Iron and Steel Institute of Japan and elected to present the Yukawa Memorial Lecture in Tokyo last December. I was elected a distinguished member of the Iron and Steel Society in Baltimore last October." . . . From Cohasset, Mass., **John Zotos,** SM '56, MTE '67, reports: "I am currently disabled due to the loss of both of my hips. I was named professor emeritus of mechanical engineering at Northeastern University." . . .

James Myers

James C. Myers, SM '89, has been named to a two-year term as chairman of the Committee C-24 on Building Seals and Sealants, one of the 132 such committees within the American Society for Testing and Materials (ASTM). Myers, a senior project manager, has been employed by Simpson Gumpertz and Heger, Inc., for 11 years. His career has focused on the design, investigation, and repair of building walls and enclosures, including curtain walls, roofs, and windows. In addition to his ASTM activities, he is an active member of the American Concrete Institute.

Uma Chowdhry, PhD '76, sends brief word from Kennett Square, Pa.: "I am R&D director of specialty chemicals at DuPont." . . . From San Carlos, Calif., we received word from **Hiroshi Menjo,** SM '85: "I am pleased to announce that I have recently joined Regis McKenna, Inc., a Silicon Valley-based, high-tech consulting firm. As a principal, I will be responsible for primarily Japanese clients, among other Asian clients. Our strength is in developing marketing strategies for novel high-tech products. I look forward to opportunities to work with MIT alumni." . . . **Robert C. Ruhl,** PhD '67, reports: "I am now VP for engineering at Technology Management, Inc., in Cleveland, Ohio. This company is developing a solid-oxide fuel cell system based upon my invention. Both natural gas and diesel-fueled versions are being pursued, with initial systems sales expect in about three years." . . . **Hamlet Herring III,** SM '83, is a senior strategic consultant at AT&T Microelectronics in Berkeley Heights, N.J. . . . . **Rodney E. Hanneman,** SM '61, PhD '64, writes: "I am VP and CTO at Reynolds Metals Co., in Richmond, Va. I have been active on the Science Museum of Virginia Foundation board, having recently arranged for the gift of the Aluminaut deep sea submarine to the musuem. I

also currently serve as chairman of the Aluminum Association's technical committee." . . . **Anil R. Chaudhry**, SM '83, reports: "I was recently promoted to be the operations manager of a new NIST-Manufacturing Extension Center at the Edison Materials Technology Center in Dayton, Ohio. We will be helping the small- and medium-sized companies with their defense conversion and manufacturing technology needs."

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IV ARCHITECTURE

Kenneth Schwarz, MAR '66, sends word from Mill Valley, Calif.: "As principal in Anshen & Allen Architects, I have been traveling extensively to England, where I work on the complete rebuilding of medical campuses at Durham, Peterborough, and Norwich. My team has just been appointed for the new campus for the Royal Infirmary of Edinburgh, Scotland, one of the world's largest and most prestigious academic medical centers." . . . From Silver Spring, Md., **Stephen Kendall**, PhD '90, writes: "I have been spearheading efforts to introduce open building into the U.S. residential construction industry. I've been to national workshops hosted by Armstrong World Industries and Fannie Mae. Study trips to Holland and Japan last summer confirmed a high level of open building activity there." . . . **Marian Scott Moffett**, MAA '73, PhD '75, has been named associate to the vice chancellor for academic affairs at the University of Tennessee at Knoxville. . . . From Preston, England, **N. Keith Scott**, MAR '55, reports: "I retired as chairman from Building Design Partnership in 1989, after 38 years with the design practice. I remained as a consultant from 1989 to 1992. I'm now a private architectural consultant (the Keigth Scott Partnership) working on town centre renewal and private housing in the U.K. and in the United States. I'm also a principal in the Park City, Utah, practice (SMS partnership). I'm the architect to the dean and chapter of Liverpool Cathedral, chairman of the Lake District summer music festival, and chairman of the B.D.P. Music Society."

Robert H. Dietz, MAR '44, sends news from Allyn, Wash.: "I had a rotator-cup operation—too much golf. I spend six months in Borrego Springs, Calif., and see **Bill Knowles**, MAR '32, often." . . . From Braintree, Mass., **Bhagchand D. Nayak**, MAR '70, reports: "I am a president of B.D. Nayak Architects & Planners, Inc. The firm was established in 1985 and specializes in luxury homes and commercial buildings. The Falmouth Plaza renovation in Falmouth, Mass., received two awards from the Cape Cod & Islands Board of Realtors, Inc., and Falmouth Council of Civic Beautification." . . . **Crawley Cooper**, MAR '59, writes: "My book, *Laboratory Design Handbook*, has been published by CRC Press. I am a principal in the architectural firm of Jung/Brannen Associates, Inc. I serve on the Town of Lincoln planning board, the Cambridge Reservoir Watershed Advisory Committee, and the Lincoln School Building Commitee." . . . **Kurt Eichenberger**, MAR '82, reports: "I am most pleased to announce my marriage October 22 to Donna Grey Anderson, who is a pediatrician here in Raleigh, N.C. My practice continues to do well; we received an AIA Commendation for our recently completed transitional housing facilty for the homeless, also in Raleigh. Current projects include the restoration/adaptive resuse of the Lake Mattamuskeet pumping station (a national historic register property) for use as an environmental education center and U.S. Fish & Wildlife Service visitor center in Hyde County, N.C."

Stanley P. Steinberg, MAR '59, has been named both chairman of Sony Retail Entertainment and president of Sony Development in New York, N.Y. He was formerly executive VP at Walt Disney Imagineering in Glendale, Calif. . . . **Rex M. Ball**, MAR '58, has been appointed by the White House to the architect's position on the seven-member U.S. Commission of Fine Arts. Among the 45 architects who have served on the commission since its founding in 1910, are the recently deceased **Pietro Belluschi**, past dean of the School of Architecture and Urban Planning at MIT. The commission typically reviews the designs for national buildings, landmarks, sculptures, parks, and commemorative coins. In addition, it provides general advice to the President and Congress about questions of art such as the authorization of memorials and the establishment of a competitive process for securing design services for the federal government. Ball is a resident associate of the Smithsonian Institution, a founding member of its National Musuem of the American Indian, and member of the National Press Club. He holds membership in the National Trust for Historic Preservation, the New York Museum of Modern Art, the National Building Museum, French Friends de la Vielles Maisons, the Frank Lloyd Wright Foundation, and the Octagon Society.

Rex Ball

Krzysztof Wodiczko, Course IV associate professor, has been named director of the Center for Advanced Visual Studies at MIT. He replaces **Otto Piene**, Course IV professor emeritus and director emeritus, who retired in 1993 after 20 years in the post. Piene will continue to chair the MIT Advisory Council on Art and Technology. The CAVS was established in 1967. Its founding director was painter and author **Gyorgy Kepes**, Institute Professor emeritus. Wodiczko, who is internationally recognized for image-projection creations with strong links to social issues, has used homelessness as a recurring theme since 1984. . . . **Raphael Fischler**, SM '87, MCP '87 (XI), spent a year as a Lady Davis Fellow at the Technion in Israel, and is now teaching in the urban planning program at McGill University in Montreal. . . . **Michael Skeldon**, '88, has been named VP of KRI Managment, Inc., in Lexington, Mass. The company provides construction consulting and program management services to institutional, bio/pharmaceutical, healthcare, and commercial clients throughout New England. Skeldon has been

Stephen Casentini

with the Kennedy Companies, which includes KRI and Kennedy & Rossi, since 1986. Current KRI clients include Faulkner Hospital, Genzyme Corp., and MIT. . . . **Stephen A. Casentini**, MAR '83, has been promoted to associate at Earl R. Flansburgh + Associates, Inc., a Boston-based architectural and interior design firm. Casentini has, since 1990, been a member of the ERF+A design team, working on numerous educational and office/commercial facilities.

The Association of Alumni and Alumnae has been notified that **Clara Rosalie C. Carson**, '47, of Milwaukee, Wis., died on January 17, 1994. No further information was provided.

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V CHEMISTRY

Evelyn Shen, SM '90, reports: "I'm working as an associate at the patent law firm of Fish & Richardson, in the Boston office. I specialize in pharmaceutical, chemical, and biomedical technologies. I received a JD in 1994 from the Boston University School of Law, and an *American Jurisprudence* Award in intellectual property trial advocacy." . . . **William R. Lyman**, PhD '47, writes: "I retired from Rohm & Haas Co. in 1985. I have worked part-time from time to time as a consultant to R&H on pesticide residue in plants and animals." . . . From Bloomington, Minn., **Willliam A. Peter, Jr.**, PhD '72, writes: "With four grown and married children and four grandchildren it is now time . . . to start another new corporation: Pharmaceutical Care Outcomes, Inc. We work with software to help consumers/patients better understand their drugs and personalized care plan by their pharmacists and doctors. It's exciting to provide to consumers their medical summary and recommendations with the aid of unique healthcare software." . . . **Karen Root Caldwell**, SM '75, reports: "On September 1, 1994, I began an appointment as assistant professor in the Department of Chemistry and Physical Science at Pace University's Pleasantville campus."

From Oxford, Miss., **Mankil Jung**, SM '78, sends word: "I am an associate professor of medicinal chemistry at the University of Mississippi. I serve on the editorial board of an international journal, *Current Medicinal Chemistry*, published by Bentham Science Publishers in The Netherlands." . . . **John E. Sheats**, PhD '66, reports from Princeton, N.J.: "I directed an ACS project SEED at Rider University during the summer of 1994, supervised two high school teachers for the Research Corporation Futures in Science Program, and chaired a symposium on inorganic and organometallic polymers at a national meeting of the ACS in Washington, D.C., in August 1994." . . . **Frank W. Dobbs**, PhD '61, writes: "I retired last year from Northeastern Illinois University, where I had been a faculty member for 31 years. I was also chair of the Chemistry Department for 6 years and dean of the College of Arts & Sciences for 12. I have written or co-written four textbooks, two of them with my wife, Carrie." . . . **Keith Stine**, PhD '88, sends news: "I am an assistant professor of physical chemistry at the University of Missouri at St. Louis. There are two graduate students and 1 postdoc in my research group, which is focused on surface chemistry." . . . **Robert Beer**, PhD '90, and Susan Frankenberg were married on September 18, 1994. Beer is an assistant professor of chemistry at Columbia University.

Ze'ev Shaked, PhD '81, has been promoted to senior VP for pharmaceutical development at ImmuLogic Pharmaceutical Corp. in Waltham, Mass. Prior to joining the company in 1991, Shaked worked at Berlex Biosciences, Inc., and at Cetus Corp. He has made major contributions to building ImmuLogic's development and manufacturing functions, and in his new position will assume responsibility for management of the company's West Coast research facility. . . . **Gerald N. Wogan**, the

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Underwood-Prescott Professor of Toxicology at MIT, director of the Division of Toxicology in the Whitaker College of Health Sciences and Technology, and a member of the Department of Chemistry, has been elected to the Institute of Medicine. . . . **John A. Latham,** PhD '85, is one of four newly appointed scientific directors at Darwin Molecular Corp. in Bothell, Wash. Latham has a strong background in several areas of chemistry and biochemistry. He joins Darwin as director of chemistry after five years at Gilead Sciences, where his work involved the use of combinatorial chemistry methods in the development of specific therapeutic compounds.

The Association of Alumni and Alumnae has been notified of the following deaths: **Xin Xu,** PhD '91, of Cambridge, on August 25, 1994, and **Edward A. Mason,** PhD '51, of Barrington, R.I., on Ocober 27, 1994.

Alumni/ae may send information for Course News to <mitalum@mitvmc.mit.edu>.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

From Marinette, Wis., **Kenneth Exworthy,** SM '59, writes: "I worked in electrical engineering for about 25 years, then started teaching at the Northeast Wisconsin Technical College. I have classes now in instrumentation, digital circuits, and radio. I enjoy teaching immensely. My MIT experience was a high point in my life. I enjoy hearing about RLE and other news of the Institute. . . . **Charles D. Trawick,** SM '80, sends word from Tucker, Ga.: "After over 13 years of designing esoteric instrumentation for Scientific Atlanta, I recently trasferred to the 'set-top' division of the company. I am now designing parts of 'digital interactive' set-top units, used to decompress video transmitted over cable networks in digital form. Quite a culture shock. My wife, Susan, a pediatrician, continues to be busy in primary care. I could make some disparaging remarks about managed care, but I won't. The three little Trawicks, aged 8, 5, and 3, continue to flourish." ... **James C. Sethaves,** SM '62, reports: "I retired from A.F. Cambridge Research Labs at Hanscom Air Force Base in Bedford, Mass. I'm now living in Cotuit on Cape Cod and making new friends with the MIT Club of Cape Cod. My wife, Janet, is also retired, from teaching in the Burlington, Mass., public school system. We both enjoy the Cape and its many bike trails and sandy beaches."

Jim Pierson, SM '49, writes: "After many years variously in the military-industrial complex, I am chairing the board of an all-volunteer senior condominium." . . . **Roger Schell,** PhD '71, sends word: "I have taken a position with Novell, Inc., in Provo, Utah, as senior development manager of Information Security. We are leading development of computer security and crypotography capability for the Novell family of products." . . . From Huntsville, Ala., **Albert A. Mullin,** SM '57, writes: "I am still working on my logical puzzles/problems, a taste for which I developed in Course VI. Here's a sample: Give a good example of a villanelle which backwards is a sonnet followed by a limerick." . . . **Sandor Schoichet,** SM '81, EE '81, sends news from San Rafael, Calif.: "Last October was my first anniversary at Genentech, Inc., where I am now director of biostatistics and information sciences in the Medical Affairs Department. After 15 years as a technology strategy consultant and project manager, I finally let one of my clients hire me. The sense of focus and ownership has been enjoyable, and I am traveling less, so I have more time to spend with Nicholas, my 4-year-old son."

Donal K. Holway, SM '47, writes: "I still work about half-time on hydroelectric projects in the United States and abroad, mostly as a consultant." . . . **Raymond W. Kinsley, Jr.,** EE '68, reports: "I'm continuing my progress of drawing plans for using 50 pounds of old transformer iron in the most useful way. I've been reading electronics club books, and trying to understand Mr. Gottlieb." . . . **Donald R. Ferguson,** EE '57, writes: "I have completed 25 years in the Worldwide Church of God where I have served as a deacon since 1975 and in the choir since 1969. My wife, Elfriede, is healthy, daughter is married with two kids, and son writes installation drivers for computers." . . . **William C. Jones,** SM '52, sends word: "I retired from AT&T (30 years at Bell Labs, 11 years at Network Systems) in May 1993. I'm currently enjoying a little travel to meet with 'old' friends and seeing our children and grandchild." . . . **William M. Crampton,** SM '55, reports: "I retired from Honeywell in 1986 and moved to rural Bear Lake, Mich., in 1988. We winterized what was then our summer cottage and added on to the house in 1989. We are still trying to get the inside finished. Both my wife, Jeanne, and I are heavily involved in volunteer activities—mostly conservation/environmental programs. I think we are busier now than when I was working. We are definitely enjoying retirement. We usually try to take the month of March off to go to the Southwest and Baja, Mexico. Another trip we try to make now and then is to visit our two daughters in Minnesota."

Rudolph A. Schlais, Jr., SM '65, has been named president of General Motor's China Operations. Previously, he was general manager of the company's Packard Electric Division in Youngstown, Ohio. . . . **Robert A. Piankian,** SM '72, sends this update: "On the professional side, in February, I cofounded my third company, The Solutions Group, Inc., and immediately landed a one-year project, which is nearly successful completion. We are a consulting company that designs and implements management information systems and voice response systems to customer requirements. Some of the nontechnical skills which have served me well as president and which I would recommend any aspiring consultant to cultivate include patience and diplomacy. My musical life continues, as I am now starting my third year on the piano and my sixth year on the trombone. The latter I play in four community bands (one of them is a marching band) and a community orchestra. The discovery that I could learn an instrument and make music remains one of the greatest surprises in my life. I am still at work on a book about learning a musical instrument that is anecdotal, informational, and motivational. I can be contacted by way of e-mail: <rap@world.std.com>.

On August 1, 1994, **Alan Baratz,** SM '79, PhD '81, was appointed CEO at Delphi Internet Services. Baratz had been a senior executive with IBM in Armonk, N.Y. Most recently he held the position of IBM director of strategic development with responsibilities for IBM's

network services. Baratz was previously group director of high performance computing and communications in IBM's Multimedia Division. In that capacity, he played a significant role in the establishment of the Internet and he led IBM's efforts in the creation of the NSF Network, the nationwide backbone of the Internet. . . . **Michael G. Hluchyj**, SM '79, EE '79, PhD '82, has been apointed VP and CTO at Summa Four. In this position, Hluchyj is responsible for identifying and assessing worldwide strategic market requirements and technology trends, defining, articulating, and implementing the company's current and future product enhancements and developments. Hluchyj was most recently director of network research at Motorola Codex and previously he was on the technical staff at AT&T Bell Labs. A pioneer in ATM switching technology and traffic management, Hluchyj has been published widely on subjects such as multiple access communications, broadband switching, multihop lightwave networks, and traffic analysis and bandwidth management in integrated networks. . . . **Roberto C. Medrano**, SM '82, has been appointed VP for sales and marketing at Alpha Systems Lab, Inc., a supplier of multimedia, video conferencing, and telesurveillance products. With more than 12 years of experience in high-technology sales and marketing, Medrano has worked at Avnet Computer, Sun Microsystems, and Daisy Systems Corp. In his new position, Medrano oversees new product launches, channel development, advertising, promotion, and public relations. . . .

Irwin M. Jacobs, SM '57, ScD '59, chairman and CEO of Qualcomm, Inc., has been awarded the 1994 National Medal of Technology, the highest award bestowed by the President of the United States for extraordinary achievements in the commercialization of technology. Jacobs was cited for "his vision, innovation, and leadership in the field of digital wireless communications over the past 25 years" and the "development of Code Division Multiple Access as a commercial technology adopted as a U.S. digital cellular standard providing increased capacity, quality, and services, and greatly enhancing the U.S. position in the international telecommunications marketplace." The Code Division Multiple Access (CDMA) technology developed by Jacobs provides a capacity increase of 1,000 to 2,000 percent over existing cellular systems and allows for an easy transition from analog to digital systems with a minimum of frequency planning and allocation of radio spectrum. CDMA provides excellent voice quality with few dropped or blocked calls, an imperceptible hand-off between cells, and inherent privacy and security. In addition, it supports wireless fax and data, and could lead to bringing phone service to hundreds of millions of currently unserved people worldwide. Jacobs began his career as an assistant/associate Course VI professor at MIT and a staff member at RLE. A textbook on digital communications he co-wrote while at MIT, *Principles of Communication Engineering*, is still in active use. From here he went to the University of California/San Diego, then to Linkabit, a company he cofounded in 1968. He cofounded Qualcomm in 1985. Currently the fastest growing company in San Diego, Qualcomm hires 50 new employees a month.

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VI-A INTERNSHIP PROGRAM

At Lydia's insistence, I humbly but proudly report that another honor has come my way. Northeastern University, my undergraduate alma mater, feted me at a presidential recognition luncheon on October 30, as the winner of their 1994 Outstanding Alumnus Award in the field of education. There were five other such awards, one each in the categories of arts & humanities, business & industry, health sciences, public service, and science & technology. The luncheon and ceremonies had 350 attendees. The special guests (all of whom were either MIT or NU affiliated) seated with me were **Lydia O. Wereminski**, whom most of you know has made VI-A function so well 'lo these many years; **Carey M. Rappaport**, '80 (VI, XVIII), SM '82, EE '82, PhD '87, a VI-A student when I was director who is now a professor on Northeastern's electrical & computer engineering faculty, and his wife, **Ann W. Morgenthaler**, SM '88, EE '88, the daughter of Professor **Frederic R. Morgenthaler**, '55, SM '56, PhD '60, who is currently in charge of MIT's EECS graduate office; and my nephew (he recently received a BS from NU) and his wife.

The October 1994 issue of the Boston IEEE's *The Reflector* reported that **Tracy Clark**, '83, SM '91, addressed the Instrumentation & Measurement Society on "Position Sensors for Linear Motor Magnetic Propulsion (Maglev) Systems." Tracy is currently working on a PhD in MIT's Laboratory for Electromagnetic & Electronic Systems. . . . The November 1994 issue of the same journal ran a write-up on **Edward B. Roberts**, '57, SM '58, SM '60 (XV), PhD '62 (XIV), mentioning the talk he gave to the IEEE's Entrepreneur's Network entitled "Building Successful High-Tech Companies Through Entrepreneurial Teams and Market Focus." Roberts is the David Sarnoff Professor of Management of Technology at the Sloan School where he has been a faculty member since 1961. . . . **Stuart E. Madnick**, '66, SM '69, SM '69 (XV), EE '71, PhD '72, is a co-recipient of the 1994 Jay Wright Forrester Award for his book *Software Project Dynamics: An Integrated Approach*. The book's other author is Tarek K. Abdel-Hamid, PhD '84 (XV), a professor at the Naval Postgraduate School in Monterey, Calif.

Visitors to the VI-A office have included: **M. Kyle Kapuscinski**, '90, SM '92, with Motorola Corporate Research; **Ronald W. J. Lau**, '69, SM '70, director of engineering in the business systems division at Octel Communications Corp., in Milpitas, Calif.; **Edward W. Maby**, '73 (VI, VIII), SM '75, PhD '79, faculty member at Rensselaer Polytechnic Institute in Troy, N.Y., who discussed his hopes to establish a VI-A-like program at RPI; **Robert P. Gilmore**, '76, SM '77, who was on campus recruiting for a second year of VI-A students for Qualcomm in San Diego, Calif.; and **Ernest D. Vincent**, '70, SM '72, who holds the honor of being Lowell Institute's most senior instructor (20 years) and now lives is Windham, N.H.

Philip O. Martel, '71, SM '72, has left G.E. Co. in Pittsfield, Mass., and has formed a company called SenTech, Inc., in Lexington Mass. SenTech consults in acoustics and signal processing. . . . **Bruce B. Parente**, '58, SM '59, EE '61, PhD '66, lost his home in Northridge, Calif., to the January 1994 earthquake. There was no personal injury to him or his family. His consulting business with clients such as Florida Power & Light, BellSouth, and Nevada Power continues to go well. . . . **Bradford T. Spiers**, '93, SM '93, is working with Swiss Bank Corp.'s London office, where he expects to be located for awhile.

Feedback from VI-As around the world and the nation has picked up since I included an e-mail address at the bottom of the VI-A column. I try to read and reply every few days, so keep it up!—John A. Tucker, director (emeritus) and lecturer, VI-A Internship Program, MIT, Room 38-473, Cambridge, MA 02139-4307; <jat@fenchurch.mit.edu>.

CourseNews

VII BIOLOGY

Sol Aisenberg, PhD '57, writes: "I am active in technology evaluation, enhancement, and transfer, and I assist in defense conversion. I work with a team of other inventors to make inventions on demand, at no cost, for companies wanting to grow through new products. I evaluate patents to enhance them, and I identify a way of bypassing patents. It is enjoyable working with a wide range of technology opportunities. Working at my home office in Natick, Mass., is very productive." . . . **Adelaide T. Sundin**, '47, reports: "Some years after graduation from the Mass. College of Art in sculpture, I studied ceramics at MIT with particular interest in how types of porcelain could be applied to art. I now have a wonderful career making bas-relief portraits in Parian porcelain of families all over the country. My husband, an engineer, is from Sweden, and our son **Olof H. Sundin**, PhD '81, is an assistant professor in neurobiology and in basic research at the Wilmer Eye Institute at Johns Hopkins Medical School. Our son Eric works with the MIT Industrial Liaison Program."

Clemens E. Prokesch, SM '45, sends word: "On July 1, 1994, I was elected as a Fellow of the American College of Physicians. An academic convocation ceremony will be held in Atlanta in March 1995." . . . **Jerome W. Riese**, PhD '58, reports: "On December 31, 1994, I retired as senior research fellow at Kimberly-Clark Corp. R&E, in Neenah, Wis." . . . **Arndt von Hippel**, '53, is the author of *Human Evolutionary Biology: Human Anatomy and Physiology from an Evolutionary Perspective* (Stone Age Press, 1994). The book jacket reads: "In his inimitably upbeat and irreverent style, von Hippel demonstrates how the latest scientific findings confirm a tortuous progression of events from the universal Big Bang to you." This is the fourth book for the Anchorage-based surgeon and teacher.

The Association of Alumni and Alumnae has been notified that **Denise J. Strieder**, '65, of Chestnut Hill, Mass., died on October 17, 1994. No further information was provided.

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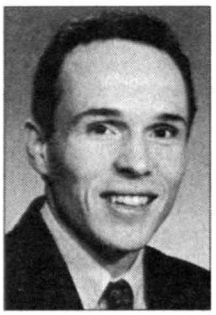
VIII PHYSICS



Douglas Albagli

Douglas Albagli, PhD '94, has joined General Electric as a physicist in the company's R&D Center located in Schenectady, N.Y. . . . **J. Rand McNally, Jr.,** SM '41, PhD '43, writes: "When I was in Poland for an international nuclear conference in the '80s, I was invited to present a paper on "Ignition of the Atmosphere." In 1987 I visited with Andrei Sakharov and discussed this topic while in his Moscow apartment. In 1994 I was invited to China to speak on the same topic but unfortunately I suffered an anomalous heart beat and had to cancel. See *Fusion Technology*, January 1991." . . . **Stefan Anderson,** SM '93, is in his second year as a science teacher at Breck School in Minneapolis, Minn.

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IX BRAIN AND COGNITIVE SCIENCES

Ann M. Graybiel, a Course IX professor of neuroanatomy, has been elected to the Institute of Medicine. She was one of 50 new members elected in recognition of major contributions to health and medicine or to related fields.

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X CHEMICAL ENGINEERING

From Newton Square, Pa., **Dilip Rajagopalan,** PhD '91, writes: "After working for three years for Mobil Research in Paulsboro, N.J., I moved last August to Central R&D at DuPont in Wilmington, Del., where I work on transport phenomena modeling." . . . **Sergio C. Trindade,** SM '70, CHE '71, PhD '73, sends word from Scarsdale, N.Y.: "After five years as the United Nations assistant secretary general for science and technology, I established in 1991 SE^2T International, Ltd., a consulting company in Scarsdale. It addresses the management of change for clients worldwide, with a focus on energy, environment, and technology. I served on the advisory panel of the Office of Technology Assessment (OTA) study on the proliferation of weapons of mass destruction. I contributed chapters on technology transfer and capacity building to the Agenda 21, the action program stemming out of the U.N. Rio Conference on Environment and Development. In addition, I designed conceptually and led the early implementation of the UNEP International Environmental Technology Center in Osaka and Shiga, Japan." . . . **Chuck Herak,** PhD '89, reports from Wilmington, Del.: "I've completed an MBA at the University of Delaware and am now working at Hercules, Inc. I was recently promoted to the position of product supervisor."

Clyde K. Smith, SM '35, sends news from San Mateo, Calif.: "I'm still hale and hearty at 82. I'm in my 70th year of volunteer 'docenting' at the California Academy of Sciences. I attended the San Franciso national meeting of AIChE last November. I've been a member for 51 years. I'm also a member of the MIT Club of Northern California." . . . **Ray W. Harris,** SM '50, writes: "1994 was a great year! I lived in San Franciso for a few months in order to learn about that fascinating city . I also took a trip to Hong Kong and Bangkok and expect to hit Hawaii before the year is over." . . . **David S. Hacker,** SM '50, sends word: "I retired on December 31, 1994, from the Amoco Research staff. I plan to establish a thermophysical property laboratory as a not-for-profit endeavor at the Basic Industrial Research Lab at Northwestern University." . . . **William F. Beck,** ScD '64, has been elected executive VP of FMC Corp. In his new position, Beck is responsible for FMC's globalization efforts, corporate development and corporate marketing, and oversight of chemical technology programs. With FMC since 1964, Beck has held several positions, most recently as VP, head of FMC Europe, and as general manager of FMC's Chemical Products Group.

Walter Godchaux, Jr., SM '35, of Slidell, La., died on June 19, 1994. As a chemical engineer in New Orleans, Godchaux was in charge of production for Godchaux Sugars and later was president of Nadustco, Inc. He was a member of the local chapter of the AIChE and a local counselor for student recruitment for MIT. . . . The Association of Alumni and Alumnae has been notified that **Robert D. Scott, Jr.,** SM '35, of Madison, Va., died on May 18, 1994. No further information was provided.

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X-A PRACTICE SCHOOL

Professor **Robert A. Brown,** head of the department, says the annual meeting of representatives of graduate fellowship sponsors—including many fellowships for X-A students—is like a visiting committee meeting, only less formal—younger people, different viewpoints, more give-and-take; he likes it. Last fall the agenda included:

1. Course I Professor Paul Barton on the new subject in systems analysis required for all students entering SCEP, designed and given at the suggestion of SCEP alumni/ae and host companies. "Systems," said Barton, "are complex artifacts of interconnected and interacting components. Optimizing each does not assure optimization of the system." So he and Course X Professors Gregory McRae and George Stephanopoulos teach system modelling, analysis, theory and control, mathematical programming, and optimization—and then give the students two problems as case studies. Barton calls it an introduction to "the typical SCEP approach."

2. Course X Professor Klavs Jensen on the new subject in statistics for all graduate students—experimental design strategies, regression analysis, factorial design, advanced screening designs, and more. "Now if you meet our students at the stations or as new employees, you can be sure they have solid backgrounds in statistics," he said.

3. Highlights of SCEP's year, reported by Course X Professor **T. Alan Hatton,** director: high interest in the Practice School by students entering the Graduate School in 1993 (12 five-year SB/SM students, 5 two-year SM students, and 18 doctoral candidates attended); similar numbers of SCEP applicants among those entering Graduate School last fall; and lively interest among prospective 1995 entrants now being interviewed—many say SCEP is a major factor in their decision to apply to MIT. Enthusiasm for SCEP is also high at both of the "regular" host companies (Michigan Division of Dow USA and Dow Corning at Midland, Mich., and Merck and Co., West Point, Pa.), and the U.S. Army Natick (Mass.) R D & E Center, which hosted a station last summer, wants to do so again this year. But the number of applicants is more than these stations' proper capacity, and it also overwhelms SCEP's financial resources—two tough interrelated problems for SCEP management. Hatton also announced that Professor **Thomas Meadowcroft,** SM '90, PhD '93, will leave his post as director of the West Point Station this June, and as of last October there were more than 60 applicants for his job.

Following afternoon activities in which the company representatives had a first chance to meet SCEP's recent, current and prospective students came a festive banquet keynoted by **Ralph Landau,** ScD '41, whose Scientific Design and (later) Halcon International companies define American entrepreneurial success in petrochemicals. Drawing on parts of his new MIT Press book, *Uncaging Animal Spirits: Essays on Engineering, Entrepreneurship, and Economics,* Landau described how his chemical engineering successes led to his increasing interest in economics, especially the role of technology in economic growth in the post-war years. His conclusion, he said: "Technology is the engine of growth of modern industrial societies." (A more focussed argument on the subject is promised in his *The Mosaic of Economic Growth,* to be published by the Stanford University Press next summer.)

Among those at the annual meeting representing companies supporting SCEP fellowships: **Kathleen A. Dennison,** SM '84, PhD '86, 3M Co., St. Paul, Minn.; **Michael Glodek,** '83, SM '84, Merck and Co., West Point, Pa.; **Charles F. Guthrie,** SM '83, Chevron Research and Technology, Richmond, Calif.; **Robert Hanlon,** SM '83, ScD '85, Mobil R&D, Paulsboro, N.J.; **George A. Huff,** ScD '82, Amoco Research Center, Naperville, Ill.; **Kirk Limbach,** PhD '89, Rohm and Haas Research Laboratories, Spring House, Pa.; **Mark Marinan,** '81, Dow USA, Midland, Mich.; **William P. Raiford,** SM '85, PhD '89, DuPont Fluorochemicals, Deepwater, N.J.; **Stephen M. Roll,** SM '87, U.S. Army Natick R D & E Center; **Jay E. Sobel,** '61, SM '63, PhD '68, Exxon Research and Engineering Co., Florham Park, N.J.; **Arnold F. Stancell,** ScD '62, retired from Mobil Oil Corp., New York; **Howard S. Stern,** '53 (XV), SM '54, E-Z-M, Inc., Westbury, N.Y.; **Paul Webley,** SM '90, PhD '90, Air Products & Chemicals, Inc., Allentown, Pa.; and **Chiquita V. White,** '85, Procter and Gamble, Cincinnati, Ohio.

Awards for 1994: the **Rosemary Wojtowicz** (SM '82) Fellowship for demonstrated concern for Practice School colleagues to **Andre LeCesne**, SM '94, now at Shell Oil Co., Norco, La; the **Jefferson W. Tester** (PhD '71) Prize for enthusiasm and leadership in SCEP to **Markus J. Langner**, SM '95, now a doctoral student at MIT; and the **J. Edward Vivian** (SM '39, ScD '45) Prize for leadership in project work to **Charlene Suwanabhand**, SM '94. Charlene was married last September 10 to Jason Gladden; they're living in Boston, and Charlene is (as of October 14) looking for a job.

From **Jack Roblin**, SM '55, who is director of engineering research and industrial development at the University of North Carolina/Charlotte, comes his prospectus as a consultant in strategic planning and process development for the Senior Consultant's Network Co., Inc., a general management consulting firm. For UNC, Jack's task is "to facilitate applied research, technology transfer, and other outreach activities between the university and the Charlotte industrial/business community.". . . **C. Judson King**, SM '58, ScD '60, has a new assignment in Berkeley: after seven years as provost for the professional schools and colleges on the Berkeley campus, he is now vice-provost for research in the University of California system. The new job, he says, "entails internal and external aspects of research as well as the linkage with three national laboratories—Livermore, Los Alamos, and Lawrence Berkeley." At the same time, King continues his independent research activities with a group of six employees.

The *San Francisco Chronicle* reported last June that **Patrick S. Wong**, SM '62, was named VP of Alza Technology Institute, a new division of Alza Corp., Palo Alto, Calif. Wong was previously executive director of R&D for the parent company. . . . From Simsbury, Conn., **Gary J. Goetz**, '73, writes of his recent promotion to director of strategic technology planning and business development at ABB, Windsor, Conn. He lives in Simsbury with wife Christine and daughter Marissa, who was old enough when Goetz wrote last June to have just lost her first tooth. Gary won the Wall Street Journal Student Achievement Award at the University of Connecticut while working for his MBA degree there three years ago. . . . **Sandy Roadcap**, SM '81, writes from Moraga, Calif.: "Have moved at Chevron Corp. from environmental engineering management to power project development and contracting—enjoying it thoroughly."

Hartselle D. Kinsey, SM '24, died at his home of 48 years in Scarsdale, N.Y., last July 9 at the age of 92. Kinsey had a major role in the Manhattan Project during World War II as manager and general superintendent of the gaseous diffusion plant at Oak Ridge, Tenn. He joined Union Carbide (manager of the Oak Ridge plant) in New York after the war, first to head divisions of the company and finally to be its VP. After retiring in 1965 he worked in Taiwan and Iran with the International Executive Service Corps.—John Mattill, *Technology Review*, Room W59-200, MIT, Cambridge, MA 02139; or send news to Carol Phillips in the SCEP office, Room 66-309, MIT; (617) 253-6600; <carol@pracschool.mit.edu>.

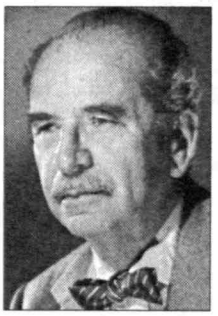
CourseNews

XI URBAN STUDIES AND PLANNING

Shih-Liang Tu, MCP '86, writes: "Although I am originally from Taiwan, I started a new job in May 1994 with the Asian Development Bank (ADB) in Manila, The Philippines. I resigned as project manager from CH2M Hill, environmental consultants, and assumed the post of environmental specialist at ADB's Office of the Environment. My job mainly involves environmental review of various infrastructure, industrial, and energy loan projects in the Asian developing countries. I also manage several technical assistance grant projects, including one on environmental impact assessment training for China and the other on the Greater Mekong River subregional cooperation in environmental technology transfer and institutional strengthening for Cambodia, China, Lao PDR, Myanmar, Thailand, and Vietnam. Feel free to contact me when traveling in the Philippines." . . . From Los Angeles, **Ken Yee**, SM '92, reports: "I am president of Ridgecrest Capital, which was selected by the Resolution Trust Corp. to be co-financial advisor on two major transactions: the $500-million land fund partnership and the $100-million

mortgage loan participation sale. Both structured transactions closed in December 1994."

In Olympia, Wash., **Krag E. Unsoeld**, MCP '89, sends an update: "I am working as an environmental planner for the Puget Sound Water Quality Authority. My oldest son, Kai Kaplan-Unsoeld, is three and my youngest son, Lee Kaplan-Unsoeld, is one. My wife, Luise Kaplan, is a consultant for the Hanford Health Information Network Resource Centers." . . . **Luis Dorich**, MCP '44, sends word from Lima, Peru: "I have been elected president of the Institute of Urbanism and Planning of Peru, a professional organization that I helped to found in 1944. From 1947 to 1964, I served as executive director of the National Planning Office of my home country. As such, I was in charge of directing studies for the master plan of Lima and other cities in Peru. I am a former regional consultant in housing and urbanization of the Pan American Health Organization." . . . **Deborah C. Jackson**, '75, has been named VP for ambulatory and community services at Children's Hospital in Boston. Previously, she was president of Morgan Memorial Goodwill Industries, Inc., also in Boston. . . . **Raphael Fischler**, MCP '87, SM '87, (IV), spent a year as a Lady Davis Fellow at The Technion in Israel. and is now teaching in the urban planning program at McGill University in Montreal.



Luis Dorich

Thomas E. Nutt-Powell, PhD '73, announces the formation of Capital Needs Unlimited in Brookline, Mass. The firm will specialize in practical solutions to complex problems, notably in the areas of multifamily housing, capital needs, and strategic planning. Nutt-Powell states: "CNU will build on the applied as well as theoretical capacities developed in the course of my 11 years as founding principal and president of On-Site Insight." Nutt-Powell has conducted research and taught in Course IV at MIT and at the Harvard-MIT Joint Center for Urban Studies. . . .

Kent Colton

Kent W. Colton, PhD '73, executive VP and CEO of the National Association of Home Builders (NAHB), has been named chairman of the board of trustees of the National Building Musuem. Colton has served as a member of the board since 1989 and most recently served as its vice-chairman. He has more than 17 years of experience in the field of mortgage finance and housing policy. Prior to NAHB, he was executive VP for policy, planning, and economic research with the Federal Home Mortgage Corp. from 1982 to 1984, and staff director of the President's Commission on Housing, 1981–82. Before heading the Housing Commission, Colton was a professor of public management and finance at Brigham Young University's Graduate School of Business.**Arthur W. Busch**, SM '52, of Wimberley, Tex., died on March 25, 1994. Busch was president of Oligodynamics Corp., where he was a consultant and environmental engineer. . . . The Association of Alumni and Alumnae has been notifed of the following deaths: **Sugijanto Soegijoko**, PhD '79, of Bandung, Indonesia, on October 16, 1994; **Fred Sherriff**, '37, of Hickory Corners, Mich., on February 21, 1994; and **James M. McCormack**, SM '85, of Great Falls, Va., on June 30, 1994. No further information was provided. *Alumni/ae may send information for Course News to* **<mitalum@mitvmc.mit.edu>**.

XII EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

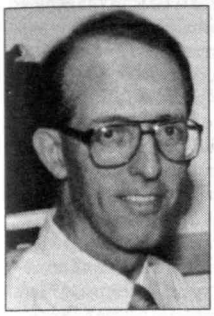
Albert M. Bottoms, SM '62, sends news from Monterey, Calif.: "From May 1994 to May 1995, I am at the Naval Postgraduate School in Monterey as a visiting professor of mine warfare. I plan on hosting an MIT Club of Northern California event. I enjoyed President Vest's visit with the Virginia Club on October 12, 1994, in Richmond, Va."

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>**.

XIII OCEAN ENGINEERING

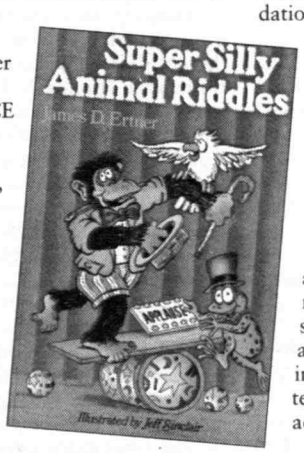
From Russellville, Ark., **Steven L. Smith**, SM '73, writes: "Last October I celebrated my 21st wedding anniversary with my bride, Danielle Jarmoluk Smith, SM '73 (X). I've been employed the last four years at Arkansas Nuclear One (a two-unit pressurized-water reactor, electric generation plant). I held the position of senior staff engineer for the Plant Modification Department. I developed and implemented a four-year, $20 million facility improvement program. Recently, I was transferred to the Plant Maintenance Department. Danielle and I have two sons, ages 9 and 13, who make my heart soar like an eagle. We love Arkansas. Write by way of <slsar@aol.com>." . . . **J.L. Coburn, Jr.**, SM '61, NE '61, sends news from E. Falmouth, Mass.: "Since 1987 I've been serving as marine operations manager at Woods Hole Oceanographic Institute." . . . We receive praise from **Henry Arnold**, SM '41, in Melbourne, Fla.: "I enjoyed a spectacular trip to Meiningen, Switzerland, with the MIT Alumni Campus Abroad. A well-balanced and organized program that I highly recommend." . . . From Springfield, Va., **Peter B. Fontneau**, SM '76, OCE '76, reports: "Although employed by J.J. McMullen Associates for the last four years and involved with lifetime support of the Navy's Aegis destroyers and cruisers, I have completed a personally significant task ashore. After eight year's work on a church building committee, and five years as chair, construction of the Accotink Unitarian Universalist Church in Burke, Va., was completed in June 1994."

Jerry R. Johnson, SM '79, writes: "I started an engineering firm, Intad, Inc., in February 1994. The firm's specialty is finite element modeling for stress, heat transfer, dynamics,



James Ertner

and fluid flow analysis." . . . **James D. Ertner**, SM '75, OCE '75, an engineering manager at Bath Iron Works in Bath, Me., is also a full-time punster and author. His book *Super Silly Animal Riddles* (Sterling Press, 1993), garnered a syndicated column replete with puns by Richard Lederer who was clearly impressed with Ertner's sense of humor. Ertner writes: The book is in most bookstores, but if it isn't, ask them to order it!" . . . Captain **Randolph M. Brooks**, OCE '76, SM '76 (XXII), reports: "I am stationed in Washington, D.C., as the director of submarine design and engineering, supporting technical efforts on the USS *Seawolf*, the new attack submarine design, and numerous fleet technical issues." . . . **Robert J. Bosnak**, SM '60, NE '60, sends news: "Involved as an NRC consultant, I recently took a trip to Russia and met with the Russian Minatom Engineering Center of Nuclear Equipment Strength, Reliability, & Lifetime on a task proposed to compare U.S. and Russian nuclear codes and standards covering design, construction, operation, maintenance, and life extension of nuclear power plant components in both countries."



Andrew B. Summers, SM '73, reports: "After 14 years as ship design manager of the DDG 51, I spent 13 months in Bath, England, designing British frigates in an exchange program with the U.K. MoD. I have now returned to NAVSEA where I am working on SC21, the surface combatant of the 21st Century." . . . **Wayne J. Rogalski**, SM '79, OCE '79, alerts us that he was promoted to general manager of the Bangor Water District in Bangor, Maine. . . . Commander **Peter C. Filkins**, SM '91 (II), NE '91, writes: "My family and I have been transferred to Riyadh, Saudi Arabia, where I am serving as the deputy for engineering and maintenance in the U.S. Naval Forces Division in the U.S. Military Training Mission to the Kingdom of Saudi Arabia." . . . Lieutenant **Douglas J. Henke**, SM '92 (II, XIII), writes from South Weymouth, Mass.: "I've been chief engineer on the U.S. Coast Guard cutter *Campbell* since 1992. I've been heavily involved in recent Haitian and Cuban migrant rescues at sea and enforcement of fisheries laws and treaties in the North Atlantic." . . . Rear Admiral **Fred L. Ames**, SM '73 (II), OCE '73, reports: "I was promoted to my present rank in the U.S. Coast Guard on September 29, 1994. I am currently residing in Burke, Va., with my wife, Holly, and daughter, Caroline. I have assumed the duties of commander, Coast Guard Military Personnel Command."

Navy Lieutenant Commander **Mary Townsend-Manning**, SM '87 (II), NE '87, recently reported for duty aboard the fleet ballistic missile submarine USS *Pennsylvania*, homeported in Kings Bay, Ga. Townsend-Manning joined the Navy in June 1979. . . . Navy Lieutenant Commander **Thomas J. Woodford**, SM '91, recently completed operations off the coast of Haiti onboard the aircraft carrier USS *America*. While off Haiti, Woodford and fellow crew members supported Navy and Army helicopter operations and special operations units. . . . **Henrietta Edmonds**, a graduate student majoring in chemical oceanography has been named a 1994–95 ARCS Scholar by the Achievement Rewards for College Scientists (ARCS) Foundation, Inc. Edmonds received a $5,000 scholarship and was one of eight students honored. In the MIT/WHOI Joint Program since 1991, her major areas of interest include tracer oceanography, interaction of sea water and oceanic crust, and continental weathering. Among her current projects is the marine geochemistry of I^{129}, a very long-lived isotope of iodine that is released in large amount during the reprocessing of nuclear waste. She has also developed a new model for the chemistry of submarine hot springs. She delivered a paper last spring at the American Geophysical Union Meeting in Baltimore, Md., and currently is a teaching assistant for a graduate course in aquatic chemistry.

The Association of Alumni and Alumnae has been notified that Commander **Phillip E. Greenwood**, SM '44, of Newport News, Va., died on April 16, 1992. No further information was provided.

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XIV ECONOMICS

Gary Loveman

Gary Loveman, PhD '89, has been promoted to associate professor in the Harvard Business School's Service Management area. For the past four years, Loveman, an expert in economic reform, has been studying enterprise reform and private business development in Poland. In his forthcoming book, *Starting Over in Eastern Europe: Entrepreneurship and Economic Renewal*, he shows that while Polish politicians have worked in vain to revitalize immense, formerly state-run companies, small businesses are creating the dynamic growth fueling Poland's transformation to a market-based economy. Loveman recently completed a casebook entitled *Managing Business Enterprises After Communism*. Loveman's current research focuses on the globalization of labor markets. As part of a two-year project, he is now looking at how several international firms in the temporary staffing industry provide high-quality service to global clients in widely disparate environments. In addition, he is doing field work to understand how a global law firm is affected by the needs of its clients.

Institute Professor **Robert M. Solow**, has been nominated to the National Science Board, the NSF's advisory and oversight group. . . . **Richard V. Butler**, SM '68, PhD '77, writes: "After a 20-year hiatus I have resumed my musical career. I'm a member and assistant conductor of the Texas Bach Choir. I've also sung solos with the Bach Choir, the Mid-Texas Symphony, and the San Antonio Boys Choir." . . . A joint note from **Barend A. deVries**, PhD '51, and **Margaret Garritsen deVries**, PhD '46, in Bethesda, Md.: "We were invited panelists at a conference in Bretton Woods, N.H., last October, commemorating the 50th anniversary of the founding of the International Monetary Fund and the World Bank, where we were staff members for four decades before our retirement. Georgetown University Press will publish Barend's book *Champions of the Poor*, an exploration of the economics and ethics of anti-poverty policies in the U.S. and developing countries." . . . **Joseph F. Quinn**, PhD '75, writes: "I was co-chair of the 1994 Social Security advisory council's technical panel on trends and issues in retirement saving." . . . **Arnold R. Weber**, PhD '58, president of Northwestern University in Evanston, Ill., has been named a director of Deere & Co. in Moline, Ill. . . . **Kenneth Thomas Rosen**, PhD '74, has been named a director of Avatar Holdings, Inc., in Miami, Fla. He continues at the University of California/Berkeley in the Graduate School of Business Administration.

The Association of Alumni and Alumnae has been notified of that **Sidney E. Chernick**, PhD '56, of Chevy Chase, Md., died on April 29, 1994.

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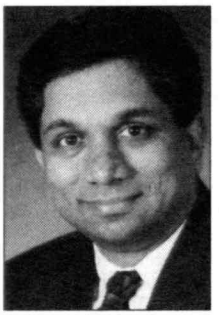
XV MANAGEMENT

Guy M. Barudin, SM '87, writes: "I've got a new job as VP for strategy and planning at RMS Technologies, a 1,400-person computer service and systems integration company outside Philly. RMS is the 5th largest black-owned company in the U.S. and the largest minority-owned technology company." . . . **Richard B. Gillett**, SM '52, reports: "Since retirement I have been director of planning giving for the Southern Province of the Moravian church. I'm also active in Kiwanis and Contact." . . . **Paul R. Jandreau-Smith**, SM '86, sends word: "I was promoted to executive VP and director of marketing at Wunderman Worldwide in the summer of '94. Brigitt and I traveled to Italy in the fall for an extended R&R trip!" . . . **Bruce G. Rosner**, SM '92, writes: "I was recently promoted to senior marketing manager of books and information services at American Express." . . . **Bryan T. St. Amant**, SM '86,

reports: "I have recently left the world of robotics to start up marketing activities for a company called BIW Connector Systems. I now actually live and work in California wine country!" . . . **Brian D. Stansky**, SM '89, writes: I continue as a VP/investment analyst at T. Rowe Price Associates My wife, Carolan, and I welcomed twin boys, Mark and Peter, on August 20, 1994. They joined 'big sister,' Emily (born March 9, 1993) at home in Ellicott City, Md." . . . **R. Gary Schweikhardt**, SM '73, sends word that he is president of the MIT Alumni/ae Association and a member of the MIT Corporation (ex officio). . . . **Andrew R. Gurbaxani**, SM '91, reports: "I am still plugging away as an IT consultant for Arthur D. Little, and sipping coffee at Coffee Connection in Belmont Center." . . . Good news from **Mei Lin D. Fung**, SM '83: "We're happy to announce the birth of our daughter, Emma Ling Shi Cosley. Also, after five years working at Intel and five years at Oracle, I've started my own consulting practice focused on cost-effective sales and marketing for technology companies." . . . From Leidschendam, The Netherlands, **James S. Law**, SM '52, sends news: "I have just joined Badger BV in The Hague, with the position of manager of advanced technology. My plan is to remain here along with my family for the foreseeable future." . . . **Bruce Jacobson**, SM '93 (XV, TPP) updates: "I'm currently working for SNET Multi-Media Services on a video dial tone project as the manager for technical planning. It's a lot of fun." . . . **Antonio T. Docal**, SM '85, has been named VP at Keystone Custodian Funds, Inc., in Boston. Previously, he was VP at Docal Associates, Inc., in Woodbridge, Conn. . . . **Ron Baakkonen**, SM '93, is still in London with Swiss Bank Corp. (SBC) in the technology department. He reports via e-mail: "Unfortunately **Vijay D'Silva**, SM '92, has left SBC to move back to the U.S. However, **Tim Wood**, SM '94, and **Tom Atkinson**, SM '94, have recently joined to continue the Sloan tradition at SBC. Susmitha Bellam and I were married in Atlanta in June 1994 and we are now happily adjusting to the London way of life. Susmitha has joined Mercury Communications as a strategic planner for European operations. Please drop us a line if you are coming through London at <baakkor@swissbank.com>." . . . **Ruth Jones**, SM '87, and Don Jones, '81 (II), write from Cincinnati, Ohio: "Don is working at LeBlond Makino Machine Tool Co. and Ruth is working at P&G. Soccer is our dominant leisure time activity. We watch, coach, and play soccer regularly. We can be reached via e-mail igeljones@aol.com>." . . . **Vijay B. Samant**, SM '83, has been named VP for vaccine operations in the Merck Manufacturing Division of Merck & Co., Inc. In his new position, Samant is responsible for vaccine manufacturing, operations, and commissioning of the new Biotech Manufacturing Complex. Samant joined Merck in 1977, working in materials management, manufacturing, and engineering before he was named executive director of safety and industrial hygiene for the corporation in 1989. Most recently, he served as VP for business affairs for the division he is in now. . . . **John A. White**, '46, dean of the College of Engineering at Georgia Institute of Technology in Atlanta, has been nominated to the National Science Board, the NSF's advisory and oversight group. . . . **Richard A. Goodman**, SM '62, and Michael W. Lawless are the authors of *Technology and Strategy: Conceptual Models and Diagnostic* (Oxford University Press, 1994). According to its jacket, the book "presents models that help put technology and its market impacts into perspective. It addresses the broad questions of how technology and markets evolve, how technology can re-order the 'rules' of competition, and how it can shift the balance of individual firms' competitive advantage." Goodman is chair of the policy and organizations faculty at the John E. Anderson Graduate School of Management at the University of California at Los Angeles. . . . **Mauro F. Guillén**, Course XV assistant professor, has written *Models of Management: Work, Authority, and Organization in a Comparative Perspective* (University of Chicago Press, 1994). In the book, Guillén explores differing historical patterns in the adoption of three major models of organizational management: scientific management, human relations, and structural analysis. He then looks at how managers have used these models in four countries during the twentieth century.



Vijay Samant

Tha Association of Alumni and Alumnae

has been notifed that **Carl W. Hamilton**, PhD '69, of Warren, N.J., died on September 6, 1994. No further information was provided.

SLOAN FELLOWS

Robert L. Swain, SM '71, writes: "I retired from NASA Langley Research Center in February 1994. I'm enjoying retirement and my first grandchild (a girl) born October 2, 1994." . . . From Laurel, Md., **Charles Steinecke III,** SM '70, sends word: "I retired in 1994 from the Department of Defense and Federal Quality Institute after 40 years of government service. Steinecke Associates, Inc., of which I am principal, serves not-for-profit boards of directors by conducting CEO searches, board effectiveness workshops, and helping boards to think and plan strategically." . . . **Gary L. Cowger,** SM '78, has been named corporate VP at General Motors Corp. Previously, he was executive in charge of North American operations at the Warren, Mich. firm. . . . **William C. Ford, Jr.,** SM '84, has been named chairman of the finance committee of the Ford Motor Co. board of directors. Prior to this title, he was VP and general manager of the Dearborn, Mich.-based company's Climate Control Division. . . . **William Harral,** SM '77, has been named president and CEO of Bell Atlantic-Pennsylvania. Harral began his career as a management trainee in the Bell Atlantic-Pennsylvania operations organization in June 1961. Before this most recent promotion, he was the company's VP for external affairs and CFO. . . . **John F. Fiedler,** SM '79, has been named president, COO, and a director of Borg-Warner Automotive in Chicago, Ill. For the past three years, Fiedler served as executive VP of North American Tire, a division of The Goodyear Tire & Rubber Co. Fiedler, who joined Goodyear in 1964, has served in a number of positions, including as president of Retread Systems Co. and as president of Kelly Springfield Tire Co., both divisions of Goodyear. . . . **Allen Latham, Jr.,** '30 (II), '36, founder of Haemonetics Corp., in Braintree, Mass., has been named an honorary member of the ASME. He was cited for "his pioneering work in the design, manufacture, and marketing of blood processing equipment, which enhances the safety and quality of the world's blood supply and increases the availability of critical blood components." Latham's engineering career began at Westinghouse Electric in 1929 with a summer job doing data reduction on steam turbine tests. He joined E.I. DuPont de Nemours in 1930, performing test studies in the field of synthetic ammonia process. From 1935 until 1941, he served as a consultant for Arthur D. Little, Inc., working in the areas of sea-water distillation equipment development, cryogenic equipment, and blood processing centrifuges. He founded Cryogenic Technology, Inc., a company that developed, manufactured, marketed, and serviced cryogenic and blood processing equipment. He also founded the Haemonetics Corp., where he served initially as chairman, president, and CEO. Latham is a member of several professional societies, including the AIChE.

Robert L. Gibson, Jr., SM '55, of Redwood City, Calif., died on June 13, 1994. Gibson was a past president and CEO of California Canners and Growers of Libby, McNeil & Libby, and was also a past chairman of the National Canners Association.

SENIOR EXECUTIVES

Claus V. Ipsen, '81, has been named CEO of J. Lauritzen A/S, in Copenhagen, Denmark. Previously, he was executive VP for finance at the firm.

Raymond Rabeharisoa, '83, of Antananarivo, Madagascar, died on October 6, 1993. Upon retiring from the World Bank after 20 years of service, he moved back to his home country of Madagascar. He was then appointed to head the committee for financial and economic coordination, a key post within the newly elected democratic government, and one that made it possible for him to help with the country's economy. . . . **Richard J. Melia,** '87, of Somerville, N.J., died on October 19, 1994. He was struck by a car while out for a morning run during a vacation in England. Melia was VP for financial operations at AT&T Technologies in Berkeley Heights, N.J. . . . The Association of Alumni and Alumnae has been notified that **Milford A. Manger,** '57, of Lynnwood, Wash., died on August 24, 1994. No further information was provided.

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XVI AERONAUTICS AND ASTRONAUTICS

Vivek Mukhopadhyay, SM '70, ScD '72, of Yorktown, Va., writes: "I joined Aeronautical Systems' analysis division at Langley Research Center where I'm working on the aeroelasticity and active control apsect of very large transport advanced concepts for the next century. I am also teaching systems theory at George Washington University." . . . **R.A. Kennedy,** AA '77, sends a concise note: "Trident I—success, Trident II—success, and SDI—success. Now tackling oil spills, trying to conquer a slippery problem." . . . **Michael Corvin,** SM '88, reports: "R&D in launch vehicle, GN&C and systems engineering at Martin Marietta Astronautics. IAC Chaper 12 Rocky Mountain Aerobatic Club (competing at sportsman level)." . . . **James F. Glass,** SM '75, writes: "I am still employed! I'm working on Mars surface explorer, pulse-detonation rocket engines." . . . **William S. BeeBee,** ScD '75, sends word: "I have started a consulting business in the area of defending against theater ballistic missiles, such as the Scud. My MIT ScD thesis has been a key contributor in this."

David Finkleman, SM '64, PhD '68, was one of seven Department of Defense employees to receive the Distinguished Civilian Service Award for 1994. Finkleman is director of studies and analysis and senior scientist for the North American Aerospace Defense Command and the U.S. Space Command at Peterson Air Force Base, Colo. The award is the highest departmental civilian honor. He was cited for "significant technical and managerial accomplishments throughout his career." His achievements include: high-energy laser development, rocket and aircraft programs, ballistic-missile launch-detection concepts, analysis for NORAD and USSPACECOM, and direct support to space and continental defense operations. Finkelman received the Navy's highest civilian award in 1981 and was designated a Meritorious Federal Executive in 1989. He is one of very few joint service civilians. He has served the Army, Navy, Air Force, the Office of the Secretary of Defense, among others. He earned his commission in 1963 and served on active duty until April 1973. During that time, he was associate professor of aeronautics at the Air Force Academy and a project leader at Kirtland Air Force Base, N.M. He was awarded the Legion of Merit when he retired as colonel in the Air Force Reserve in 1993.

The Association of Alumni and Alumnae has been notified of the following deaths: **Evert D. Wilmoth,** SM '52, ScD '59, of Franksville, Wis., on May 18, 1994; **Robert A. Darby,** SM '34, of Lacey, Wash., on May 11, 1994; and Lieutenant Commander **Sylvester M. Dulke,** SM '62, of Orange Park, Ill, on February 22, 1994. No further information was provided.

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NAMED UNDERSECRETARY OF DEFENSE

Paul Kaminski, SM '66, of Fairfax Station, Va., has been confirmed as the new undersecretary of defense (acquisition and technology). His responsibilities will include R&D, testing and evaluation, production, logistics, military construction, and procurement. He replaces John Deutch, '61, who was promoted to deputy secretary of the department. Kaminski has had a long and distinguished career in defense technology and acquisition. He currently is chair and CEO of Technology Strategies & Alliances, a technology-oriented, investment banking and consulting firm. He is also the chair of the Defense Science Board and has served as a consultant to a variety of government agencies and organizations. Among his technical contributions is significant work on inertial guidance systems and terminal guidance systems for the first generation of precision-guided missiles. Kaminski holds a bachelor's degree from the Air Force Academy, two master's degrees from MIT, one in electrical engineering and another in aeronautics and astronautics, and a PhD in aeronautics and astronautics from Stanford. From 1964 to 1984 he was a regular officer in the U.S. Air Force. He was elected to the National Academy of Engineering in 1994.

Women's Studies Alive and Well at 10

It was a spectacular finale to an anniversary year when actress Lily Tomlin made a standing-room-only appearance at Kresge Auditorium with writer/director Jane Wagner. From left: Ruth Perry, the founding director of Women's Studies at MIT, Wagner, Tomlin, and Evelyn Fox Keller, the current director of Women's Studies.

MIT's Women's Studies Program celebrated its 10th anniversary in 1994, opening with a groundbreaking conference on "Black Women in the Academy" in January and building to an exuberant, sold-out discussion in Kresge Auditorium with actress Lily Tomlin and writer/director Jane Wagner in October.

Women's Studies began as a collection of subjects, taught in several departments, in which the role of gender was an important intellectual consideration. By 1984, a critical mass had been established: a program was listed in the MIT Bulletin and an office was set up under the guidance of founding director Ruth Perry, professor of literature.

In the ensuing decade, the Women Studies Program and the demographics of MIT's student population both evolved. The proportion of women in the freshman class climbed from 29 percent to 40 percent, and women's studies now includes 26 affiliated faculty from 10 disciplines whose classes enroll close to 500 students annually. Nine students have graduated from MIT with majors in women's studies, and there are currently seven students minoring in the field and twenty-four pursuing concentrations.

A common misperception is that women's studies provides *services to* women, Perry says, when in fact the field is devoted to *scholarship about* women. Within that framework, MIT's program is distinctive for its focus on how cultural concepts of gender can affect science and technology. In fact, the current director of the program, Evelyn Fox Keller, who launched her career as a theoretical physicist, is regarded as the country's leading scholar on issues of science and gender.

"Women's studies [at MIT] has gathered together some of the nation's foremost talent in the area of gender, science, and technology," says Keller, and the program has as one of its objectives "the very difficult task of training scientists and engineers—both students and faculty—to examine and analyze assumptions they never even knew they were making."

MIT's scholars have analyzed, for example, how the use of computers in medicine does not sufficiently incorporate the expertise of nurses, how the sexual division of labor contributes to the environmental crisis, and how the popular media can both perpetuate and undermine ideologies of gender.—*Excerpted from* Tech Talk□

XVII POLITICAL SCIENCE

Edward M. Malloy, SM '70, of Bethesda, Md., writes: "I completed a three-year assignment with the U.S. Embassy in Tokyo as minister counselor for environment, science, and technology from 1990 to 1993, and am now directing the Office of Science, Technology, and Health in the Department of State. To meet my academic interests, I am teaching a graduate course at George Washington University on environmental science and technology in international diplomacy." . . . **Roger Karapin**, PhD '93, reports: "I took a job as assistant professor of political science at Hunter College at the City University of New York in the Fall of 1994." . . . From Yorktown, Va., **John Shephard**, SM '85, writes: "Virginia Governor George Allen named me to serve on the Governor's Commission on Base Retention and Defense Conversion. The panel's charter is to make recommendations to the Governor on how to minimize the impact of potential military base closures on Virginia's economy, and on what the state can do to assist industries and communities who are affected by defense downsizing. I am director of strategy at Newport News Shipbuilding Co., Virginia's largest industrial company. The firm is a division of industrial giant Tenneco, Inc."

From McLean, Va., **Nelle W. Temple Brown**, PhD '80, sends word: "After working on international legislation for nine years in the House Banking Committee, I have begun work as the external relations officer of the World Health Organization in Washington, D.C." . . . Captain **Brian L. Baker**, SM '92 (I, XVII), reports: "I serve with the Corps of Engineers in Waltham, Mass., as environmental project manager. I work on several EPA Superfund sites in New England. I was recently selected for promotion to major." . . . **David H. Guston**, PhD '93, and Kenneth Keniston are the editors of *The Fragile Contract: University Science and the Federal Government* (MIT Press, 1994). The November/December 1994 edition of *Technology Review* ran an excerpt by Guston and Keniston entitled "Updating the Social Contract for Science." Guston is assistant professor of public policy at the Eagleton Institute of Politics at Rutgers, the State University of New Jersey. Keniston is the Andrew W. Mellon Professor of Human Development in the STS Program at MIT.

The Association of Alumni and Alumnae has been notified that **John F. Falkenberg**, SM '49, of Denver, Colo., died on September 19, 1994. No further information was provided.

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XVIII MATHEMATICS

Esteban G. Tabak, PhD '92, writes: "After two years as a post-doc at Princeton, my wife and I have moved to Manhattan, where I was appointed assistant professor at the Courant Institute." . . . **Frederic Yui-Ming Wan**, '59, SM '63, PhD '65, professor of mathematics and applied mathematics at the University of Washington, has been named vice chancellor

PHOTO: MARILYN HUMPHRIES

of R&D and dean of graduate studies at University of California/Irvine. On January 1, Wan took responsibility for research policy, allocation of campus research, and graduate fellowhip funds and contracts. In addition, he is responsible for grant development—UC/Irvine receives more than $100 million annually in outside research support. Wan was formerly both an MIT and a University of British Columbia faculty member. The author of two graduate textbooks, he is an internationally known expert in the theory of plates and shells, a field of structural mechanics. He is also director of the NSF's Division of Mathematical Sciences. . . . **Donald M. Davis**, '67, has been named the chair of the Department of Mathematics at Lehigh University in Bethlehem, Pa. Davis joined the Lehigh faculty in 1974 and was promoted to full professor in 1984. He specializes in algebraic topology. Davis is the founder and director, since 1991, of the Lehigh University High School Mathematics Contest, and since 1992, he has been coach of the Lehigh Valley team in a national mathematics contest. . . . **Noel Nachtigal**, PhD '91, of the Department of Energy's Oak Ridge National Laboratory (ORNL), has been honored by the Society for Industrial and Applied Mathematics for co-writing a paper designated as one of the two most outstanding papers published on linear algebra between 1991–93. Nachtigal, a research staff member with ORNL's mathematical sciences section and an adjunct professor at the University of Tennessee, was honored for "QMR: A Quasi-Minimal Residual Method for Non-Hermitian Linear Systems." The paper introduced a new method that can be applied to solve large, sparse, nonsymmetric linear systems—it has been successfully used to solve problems arising in circuit simulation, computational fluid dynamics, electromagnetism, and materials science.

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XX APPLIED BIOLOGICAL SCIENCES

Herbert S. Waxman, '58, chair of the Department of Medicine at the Albert Einstein Medical Center and senior associate chair at Temple University School of Medicine in Philadelphia, received a special recognition award from the American Society of Internal Medicine (ASIM). Waxman, an internist who specializes in hematology, was honored for his leadership as chair of the Federated Council for Internal Medicine, an organization comprised of leaders of the six major national organizations in internal medicine: ASIM, the American Board of Internal Medicine, the Association of Professors of Medicine, and the Society for General Internal Medicine. ASIM conveys annual special recognition awards on members who have performed outstanding service to the Society and only two awards were given out this year. Waxman's research has focused on sickle-cell disease, as well as computer-assisted diagnosis.

The Association of Alumni and Alumnae has been notified that Colonel **Ralph R. Rusche**, '55 (ret.), of Palm Coast, Fla., died on September 9, 1993. No further information was provided.

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XXII NUCLEAR ENGINEERING

David R. Boyle, PhD '80, sends word from College Station, Tex.: "I retired from Air Force active duty in August 1993 and took a position at Texas A&M University. I teach one graduate course in the Nuclear Engineering Department each semester and spend the rest of my time as the deputy director of the Center for Space Power. My family and I are putting down roots in this great state; we don't plan to move for a long time." . . . **David Hearding**, SM '77, ENE '77, writes: "As a captain in the U.S. Navy, I am commanding officer of the USS *Dixon*, a submarine tender (22,000 tons) in San Diego. I was the former commanding officer of the USS *Pargo*. We visited the North Pole in April 1991, with then-Senator Al Gore on board. He wrote about his trip experience in *Earth in the Balance*. I was most recently stationed in Yohosuba, Japan, as part of the U.S. Seventh Fleet." . . . **John R. (Jack) Essig**, PhD '66, reports: "I retired from civil service and nuclear engineering. I am now working part-time as a stamp dealer. I can be reached at Red Dog Stamps, P.O. Box 885, Fairfax, Va. 22030, (703) 273-5908." . . . Captain **Randolph M. Brooks**, SM '76, OCE '76 (XIII), reports: "I am stationed in Washington, D.C., as the director of submarine design and engineering, supporting technical efforts on the USS *Seawolf*, the new attack submarine design, and numerous fleet technical issues."

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>**.

TPP TECHNOLOGY AND POLICY PROGRAM

Harry West, SM '84, PhD '86 (II), has left MIT to become director of advanced technologies at Continuum in Boston. Continuum has offices located in Boston, San Francisco, and Milan. . . . **Steve Altes**, '84 (XVI), SM '86 (XVI, TPP), and his wife, Barbara, continue to operate their own small consulting company specializing on public relations, lobbying, and technical services for aerospace companies. Last year their work took them to Moscow for three months. . . . After two years practicing law in New York with the firm Kenyon and Kenyon, **Scott Weingaertner**, '84 (XIII), SM '87, moved to the international law firm of Kilpatrick & Cody in Atlanta, where he is practicing intellectual property law. Scott and his wife, Annabelle, recently had dinner with **Ajit Kambil**, '85 (VI), SM '89 (XV, TPP), PhD '93 (XV), and his family in Atlanta. **Tatiana Gianella**, G, spoke to Scott at some length about the program before joining TPP last fall."

Jeff Dieffenbach, SM '89 (III, TPP), informs us that all is well at IBIS—they are up to 12 consultants and 14 full-time personnel. Along with the president, John Busch, Jeff is now part owner of the firm, and soon will have a new title beyond project manager. Jeff and his wife, Jennifer, bought a new home in Wayland in close proximity to the town beach of Lake Cochituate. . . . **Bertrand Rigaldies**, SM '90, and his wife, Susan, have an addition to their family. Jeremiah Jacques Robert was born on March 23, 1994. Bertrand is a software engineer at Comdial Co.

Michael Berube, '89 (I), SM '92 (XV, TPP), and his wife, Michelle, planned a trip to Australia last November. Never a dull moment in the Berube household! . . . **Lola Matysiak**, '91 (I), SM '92, has set June June 17, 1995, as her wedding date. Best wishes Lola and Rob! . . . The New Hampshire Championship Regatta was held on October 15, 1994. **Geoff Parker**, G, and **Jon Grant**, G, each had a good race as members of the Memmian Rowing Club 4+, and managed to edge out the MIT varsity for first place. Congratulations! . . . **Michael "Mick" Rookwood**, SM '92 (II, TPP), and Karen Segal are busy planning a wedding for April 30, 1995. Congratulations and don't forget to send us pictures. . . . News has reached the TPP Office that **Chris Tucci**, SM '92, and Carolyn Magnani decided to get married this past August and are planning an October 1995 wedding. Best to the two of you! . . . **Russell Cohn**, '92 (III), SM '94, was promoted to associate consultant and has been working on business development in Gemini's strategy discipline. Russ informs us that he had a great summer windsurfing! . . . **Donald Seville**, SM '94, is now a systems dynamics consulting associate at Gould-Kreutzer Associates, along with his research associate position at the Organizational Learning Center at MIT.—Richard de Neufville, TPP, Room E40-252, Cambridge, MA 02139 <tpp@mit.edu>.

Deceased

The following deaths have been reported to the Alumni/ae Association since the *Review* last went to press:

George I. Crowell, '16; October 6, 1994; Randolph, Mass.
Eaton J. Clogher, '18; October 21, 1993; Wallingford, Conn.
Gustav Fredrickson, '21; May 14, 1994; Beacon Falls, Conn.
Sherwood I. Berger, '23; May 1, 1994; Winchester Center, Conn.
William E. Stone, '25; June 12, 1994; Westborough, Mass.
Charles W. Dinan, '27; June 28, 1994; Nutley, N.J.
Carl H. Peterson, '27; October 6, 1994; East Weymouth, Mass.
Thomas G. Harvey, '28; November 26, 1992; Indianapolis, Ind.
Roger W. Haven, '28; April 4, 1994; Center Harbor, N.H.
Paul A. Johnson, '28; December 20, 1993; Honolulu, Hawaii
Alfred C. Knight, '28; October 2, 1994; Marstons Mills, Mass.
Henry N. LaCroix, '28; September 26, 1994; West Orange, N.J.
Franklin C. McCoy, '28; September 13, 1994; Chatham, Mass.
Ngeu F. Tsang, SM '28; October 23, 1994; Hayward, Calif.
Jerome Franks, SM '29; April 1994; Cincinnati, Ohio
Charles R. Oleson, '29; October 10, 1994; Marietta, Ga.
Robert M. Jacobs, '30; October 20, 1994; Lexington, Mass.
Norman C. Nelson, SM '30; February 9, 1994; Cincinnati, Ohio
Harry A. Shaw, '30; May 19, 1994; El Paso, Tex.

Hugh S. Wertz, SM '31; December 8, 1990; South Orange, N.J.
Alexander J. Chaplik, '32; June 17, 1994; Boston, Mass.
Sidney M. Edelstein, '32; September 18, 1994; West Palm Beach, Fla.
Richard E. Payzant, '33; October 8, 1994; Mashpee, Mass.
Warren A. Bjorn, '34; November 13, 1986; Columbia, S.C.
Robert A. Darby, SM '34; May 11, 1994; Lacey, Wash.
Rodolfo J. Gonzalez Garza, '34; August, 1994; Garza Garcia, Mexico
John E. Perry, '34; May 27, 1993; Plaistow, N.H.
Karl H. Achterkirchen, '35, SM '37; September 29, 1994; Camarillo, Calif.
Walter Godchaux, Jr., '35; June 19, 1994; Slidell, La.
Lester S. Lappin, '35; October 21, 1994; Miami, Fla.
Robert D. Scott, Jr., SM '35; May 18, 1994; Madison, Va.
Donald B. Wood, '35; October 31, 1994; Wimberley, Tex.
Robert L. Johnson, '37; September 5, 1994; Quechee, Ver.
David D. Locke, SM '37; April 1, 1994; State College, Pa.
Bernhard Schondorff, '37; March, 1991; Erkelenz, Germany
Fred Sheriff, '37; February 21, 1994; Hickory Corners, Mich.
Michael Zinchuk, '37; March 23, 1994; Hyannis, Mass.
James W. Barton, '39; October 22, 1994; Bellevue, Wash.
John O. Crum, '40; March 10, 1994; Visalia, Calif.
William C. McDonald, '40; January 4, 1994; San Diego, Calif.
Richard L. Ackerman, Jr., '43; September 14, 1994; Brookline, Mass.
Alfred A. Emond, '43; April 3, 1994; Elk Grove, Calif.
William O. Boschen, '44; July 18, 1994; Montville, N.J.
Phillip E. Greenwood, SM '44; April 16, 1992; Newport News, Va.
Robert S. Buxton, '45; October 17, 1994; Media, Pa.
Warren H. Miller, '45; October 17, 1994; Buffalo, N.Y.
Clara Rosalie C. Carson, '47; January 17, 1994; Milwaukee, Wis.
Ralph K. Strawn, '47, SM '51; April 6, 1994; Malvern, Pa.
Joseph A. Luceri, '48; September 7, 1994; Andover, Mass.
Richard E. Mould, '48; September 14, 1994; Encinitas, Calif.
Raffaele Belluardo, '49; October 2, 1994; Manchester, Conn.
John F. Falkenberg, SM '49; September 19, 1994; Denver, Colo.
David K. Hardin, '49; January 6, 1994; Chicago, Ill.
Charles W. Jackson, '49; August 26, 1994; Janesville, Wis.
Gilbert V.O. Cook, '51; October 28, 1994; Denver, Colo.
Edward A. Mason, PhD '51; October 27, 1994; Barrington, R.I.
Arthur W. Busch, SM '52; March 25, 1994; Wimberley, Tex.
Evert D. Wilmoth, SM '52, ScD '59; May 18, 1994; Franksville, Wis.
Robert J. Agnew, PhD '53; September 6, 1994; Pittsburgh, Pa.
David Philip Hopkins, SM '53; December 19, 1993; Sacramento, Calif.
Robert L. Gibson, Jr., SM '55; June 13, 1994; Redwood City, Calif.
Ralph R. Rusche, '55; September 9, 1993; Palm Coast, Fla.
Sidney E. Chernick, PhD '56; April 29, 1994; Chevy Chase, Md.
Milford A. Manger, '57; August 24, 1994; Lynnwood, Wash.
Sylvester M. Dulke, SM '62; February 22, 1994; Orange Park, Fla.
Robert A. Lytle, Jr., '62; September 10, 1994; Grosse Pointe, Mich.
Denise J. Strieder, '65; October 17, 1994; Chestnut Hill, Mass.
Carl W. Hamilton, PhD 69; September 6, 1994; Warren, N.J.
Devendra D. Mehta, SM '68; November 6, 1992; Windsor, Conn.
Roger Foott, ScD '73; October 4, 1994; Lafayette, Calif.
Sugijanto Soegijoko, PhD '79; October 16, 1994; Bandung, Indonesia
Raymond Rabeharisoa, '83; October 6, 1993; Alexandria, Va.
James M. McCormack, SM '85; June 30, 1994; Great Falls, Va.
Richard J. Melia, '87; October 19, 1994; Somerville, N.J.
Scott A. Weir, '89; Oct. 1, 1994; Canton, Mass.
Xin Xu, PhD '91; August 25, 1994; Cambridge, Mass.

PuzzleCorner

I report a new (for me at least) communication experience. I have met Puzzle Corner readers in strange places. For example, in August I literally bumped into one hiking in Grand Teton National Park. I am also aware that considerable science is accomplished while in airplanes (significant portions of GNAT, the GNU NYU Ada Translator, were written above 30,000 feet). However, the following paragraph taken from an e-mail message Ben Zuckerman sent to me is a first.

"By the way, I am typing and sending this message to you as I sit at 14,000 feet in the dome of the 10-meter Keck telescope near the summit of Mauna Kea, Hawaii waiting, without any real hope, for the clouds to go away so that we can open the dome."

I am sure you all join me in extending to Zuckerman the wish for eternal dark and clear skies. To see what astronomers think of while waiting for the skies to clear, see this issue's speed problem.

Problems

F/M 1. Larry Kells offers a sequel to his N/D 1 bridge problem, where 7NT was unbeatable despite one defender having 26 points.

On a later date, in another high-stakes game, I saw the same couple defend unsuccessfully against another 7NT, redoubled and vulnerable. This time in the aftermath they argued as follows:

Husband: That was really fine of you, the way you kept criticizing me for doubling 7NT when I didn't have all four suits stopped. You just did the same thing!

Wife: But I had THIRTY points! I knew we had to be able to beat 7NT. And we would have if you had led any card other than the one you did. They would have been down TEN!! But you had to lead the one card that let them make it!

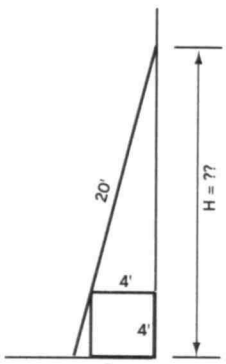
Husband: But how could I have known, when that suit was never bid?

Wife: You should have known that if you had led one of the other suits, and it turned out badly, at least they couldn't have run so many tricks in it!

Assuming they were telling the truth, reconstruct the deal.

F/M 2. Victor Baracas has a bunch of regular n-gons (prizes from winning the gon show?) and asks, "If a regular n-gon has area A and perimeter P, express the ratio $P^2/4A$ as a function and find the limit as n approaches infinity."

F/M 3. George Blondin wonders how high on the wall does a 20-foot ladder reach when it rests against the edge of a 4-foot cube?



Speed Department

Ben Zuckerman asks what letter completes the following set of letters: BADROP. He also wants the longest word or name one can construct from these seven letters (duplicates permitted).

Solutions

OCT 1. We begin with a Bridge problem from Jorgen Harmse:

	♠ A K 3 2 ♥ 9 8 3 ♦ A Q 10 6 ♣ 4 3	
♠ 9 8 7 ♥ 10 7 x 2 ♦ 4 3 2 ♣ 7 6 2		

You lead the deuce of hearts against 3NT, and your partner's ace brings down Declarer's king. Your partner leads the queen and Declarer discards. Explain the importance of your third heart (marked x).

Unfortunately a misprint caused dummy to contain 14 cards including both the 10 and T of diamonds. Since T was to stand for 10, many readers figured out the error and were able to submit correct solutions, including the following offering from Doug Abramson.

The unidentified card x is either a 4, 5 or 6 and how it is played will determine if your team will be able to take 4 or 5 tricks in hearts. If not played correctly you may not be able to get back into your partner's hand using hearts while your team has the lead. Of course taking 5 off the top prevents 3NT from being realized by your opponent so in order to play it right depends on x:

If x is a 6 then it should be played on the second trick (your partner's queen). Your partner needs to be aware that at this point his jack is the only way back into his hand to win 5 tricks so he must next lead low to your 10 and allow you to lead your 7 back to his jack and other heart.

If x is a 4 or a 5 then the way to get 5 tricks is quite different. Instead you should play your 10 on his queen, your 7 on his jack and your x on his 6 so that the lead can stay in his hand for the full set of hearts.

I just have one question, how come when I play bridge I always get hands like West in this example, but I have never seen how I play my 4, 5, or 6 to be of any significance? I guess I was never that good at bridge anyhow, but it sure was a fun excuse for staying up all hours of the night at MIT.

OCT 2. Nob Yoshigahara has a color-based cryptarithmetic problem. As usual, you are to substitute digits for letters to validate the following equations.

YELLOW + YELLOW + RED = ORANGE
RED x BLUE = YELLOW
RED x RED = WHITE

Steve Feldman found

```
  1 4 3 3 2 9
  1 4 3 3 2 9
+       8 4 6
- - - - - - -
  2 8 7 5 0 4

        1 4 8
x     6 3 7 4
- - - - - - -
  9 4 3 3 5 2

      2 4 8
    x 2 4 8
  - - - - - -
    6 1 5 0 4
```

Although Feldman did not give his solution technique, several readers have said that computer searches show that the above solution is unique.

Continued on Page MIT 26

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO: ALLAN GOTTLIEB
NEW YORK UNIVERSITY
715 BROADWAY, 10TH FLOOR
NEW YORK, N.Y. 10012,
OR TO: GOTTLIEB@NYU.EDU

MIT LIFE INCOME FUNDS

MRS. MARY HOAGLUND

HOME: Minneapolis, Minnesota

CAREER: Mary Hoaglund met her husband, James B. Hoaglund, '45 EE, '47 MG, when she was a student at Wellesley. They married in 1946, the year she graduated. She and Mr. Hoaglund lived in Boston, Los Angeles, Phoenix and Chicago while Mr. Hoaglund worked for Honeywell and then Bell & Gosset in the field of air conditioning, heating and refrigeration. ITT bought that firm, and when Mr. Hoaglund became the director for research and development for a group of companies owned by ITT, the Hoaglunds moved to Philadelphia and later to Princeton. In the early 1970s, tired of living on airplanes, he accepted the position of vice president of planning and development for McQuay-Perfex, Inc., a manufacturer of air conditioning and heat transfer equipment in Minneapolis. He became president in 1974 and chairman and chief executive officer in 1982. Mr. Hoaglund died in 1985. Mrs. Hoaglund will remarry in April 1995.

Mrs. Hoaglund holds master's and doctoral degrees in educational psychology. She has worked in educational evaluation and research in Philadelphia and Minnesota since 1969.

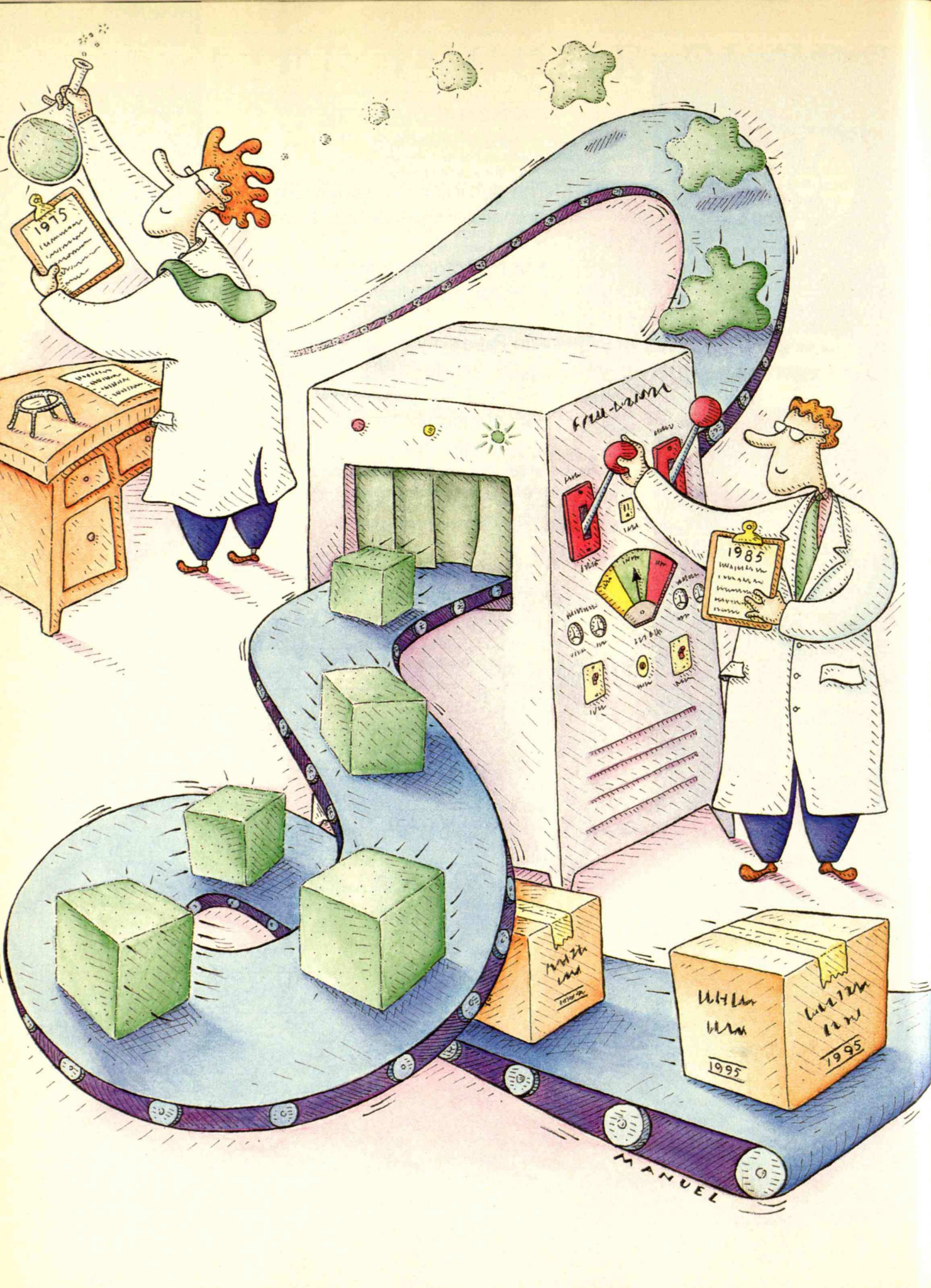
MIT LIFE INCOME FUND: Mary B. Hoaglund Fund within the Compton Pooled Income Fund.

QUOTE: Jim loved MIT. His professors and friends meant a great deal to him, and he would always make connections with local MIT groups whenever we moved. I wanted to keep contributing after his death, but it can be difficult for a widow to give without leaving herself financially insecure. That is why a life income fund is ideal — you can help MIT without limiting your own resources.

For more information about MIT Life Income Funds, write or call D. Hugh Darden, W. Kevin Larkin or Frank H. McGrory at MIT, 77 Massachusetts Avenue, Room 4-234, Cambridge, Massachusetts 02139-4307; (617) 253-3827.

Photo: Steve Kjelland and Associates
St. Paul, Minnesota

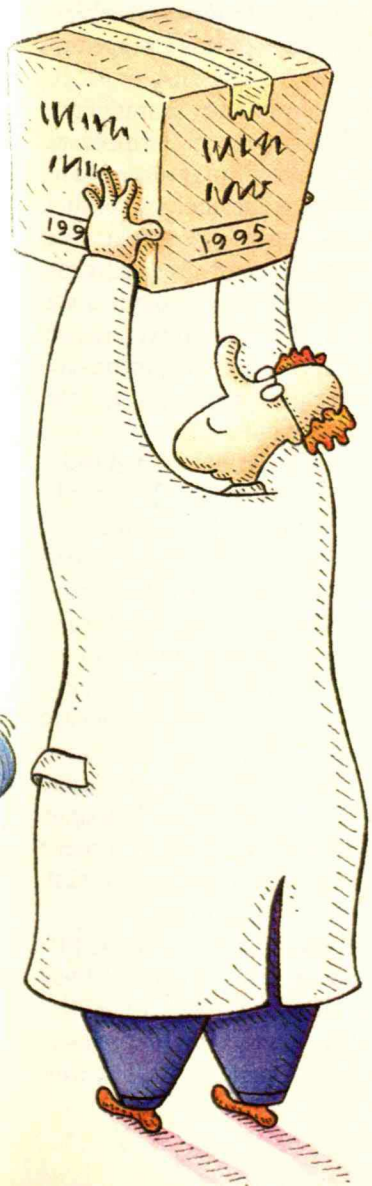
DONOR'S PROFILE


1975
1985
1995
1995
MANUEL

BY THOMAS W. EAGAR

Bringing New Materials to Market

The invention of a new material can signal the birth or death of an entire industry. Silicon chips replaced vacuum tubes; optical fibers decimated the copper telecommunications market. Many U.S. companies have invested in advanced materials in the hope of developing new and profitable businesses, but their efforts have met with mixed success. Although U.S. firms have invented the majority of materials introduced over the past half-century, they have failed to commercialize many of these innovations. ❁ One of the most important obstacles has been the failure to recognize how long commercialization is likely to take. There has typically been a 20-year interval between invention and widespread adoption of a new material (*see the chart on page 45*). This delay is significantly longer than in most other industries and makes it very difficult for a company to recoup its investment. At an annual interest rate of 8 percent, a dollar invested today must yield a fivefold return 20 years from now for investors to break even. Most firms look for a return of 20 percent per year, which means each dollar invested would have to earn nearly $100! ❁ Many companies give up if after 10 years of investing heavily they have not succeeded in developing new products. They either sell the invention or allow another firm to pick it up for free. The new firm may also have a 10-year horizon, but starting at the halfway point in the development process can mean success rather than failure. It is



Companies must form cooperative ventures to shorten—or at least transcend—the 20-year delay in commercialization.

ILLUSTRATIONS BY MANUEL KING

Product designers tend to use new materials in the same way as old ones, while materials engineers are often too optimistic about the utility of their inventions.

for this reason that Japanese companies were able to commercialize ceramic substrates, used to package semiconductors. Kyocera, the company that broke through after most U.S. companies abandoned the effort, gained more than half the world market and went on to become a multibillion-dollar business, and for several years was the most profitable company in Japan.

The 20-year time frame also limits the profitability of new materials: By the time a material comes to market, the patent protection afforded the original invention is at the end of its tenure and proprietary advantage is lost. What's more, products that incorporate new materials today have ever-shorter life cycles, so the period over which a company can recoup its investment is brief. For example, the life span of the phonograph was 70 years, that of magnetic tape 30 years, while compact discs may become obsolete within 20 years.

Fortunately, there are a number of steps producers and would-be users of new materials can take to cut the lag between development and commercialization. In particular, companies can take a more rational approach to investing in advanced materials by emphasizing cooperation rather than competition.

Failure to Communicate

Poor communication between inventors of new materials and product designers who might use them is a key factor holding back commercialization of novel substances. One example of miscommunication occurred in the substitution of plastic panels for steel panels in the household refrigerator.

In the 1950s, both the inner and outer panels of refrigerators were made of painted steel. Shelves were bolted or welded to these panels. The refrigerators were very durable: I have a freezer in my garage of this vintage that continues to work fine.

During the 1960s and 1970s, appliance manufacturers began to replace the steel inner panels with plastic panels, which were less expensive to produce. However, they still used bolts to attach the shelves, as they had with the steel panels, failing to recognize that because plastic has less inherent strength and stiffness, the panels were apt to crack more easily around the bolt holes. I purchased four or five new refrigerators over a 20-year period, not because the compressor failed, but because the shelves broke and repairing the cracked plastic panels was too difficult.

During the 1980s, as product designers gained more experience with plastic, they learned that they could mold the shelf support directly into the plastic panel and build in ribs to make the panel stiffer. These redesigned panels and shelves are as strong as the old steel inner panels and shelves, less expensive to assemble and manufacture, more resistant to corrosion, and easier to clean. But it took decades of product failures and changes for designers to learn how to use the plastic most effectively.

Product designers tend to use new materials in the same ways as the old materials. As a result, early designs with new materials rarely demonstrate their full potential. Designers may then develop a bias against the new material, delaying commercialization further.

For their part, materials engineers are often too optimistic about the usefulness of their inventions. Many new materials are developed to maximize a specific property, such as strength. Engineers may ignore secondary requirements, such as corrosion resistance, ease

THOMAS W. EAGAR is a professor of materials engineering at MIT and codirector of its Leaders for Manufacturing Program, a partnership with U.S. companies that aims to educate modern technological managers.

of fabrication and repair, or recyclability. After all, it is not easy to develop a material that meets or exceeds a dozen disparate design goals. Unfortunately, failure to meet these secondary requirements can prevent the adoption of the new material.

The design of new high-temperature superconductors (HTSCs) illustrates this problem. In early 1987, scientists announced that they had developed ceramic materials that retained their superconductivity at temperatures more than five times higher than other materials, an extraordinary—and unexpected—accomplishment. And unlike earlier materials, the new ceramics conducted a small amount of current even when subjected to powerful magnetic fields. There was hope that these materials could be used to develop powerful magnets that could lift trains above their tracks for frictionless travel, for example, or reduce the size and increase the efficiency of many types of equipment, from electric generating plants to transmission lines.

However, ceramic HTSCs did not have all the properties required for use in such a powerful magnet. They have very low "critical current density": when enough current is run through the coils of ceramic wire to create a high-intensity magnetic field, the ceramic loses its superconductivity. The highest currents that the earliest HTSCs could tolerate were 10,000 times lower than those needed to generate the desired magnetic field. The coils of a high-field magnet must also withstand stresses powerful enough to snap steel bands. Ceramic HTSCs are very brittle; they just cannot stand up to this much stress. Even today, ceramic HTSCs are orders of magnitude away from commercial success.

Communication barriers like these can be overcome only if materials development engineers work closely with product designers. The researchers developing new materials need to be aware of the design requirements of potential users. Product designers, in turn, must work closely with materials engineers to modify existing designs to ensure that they capture the advantages of the new material.

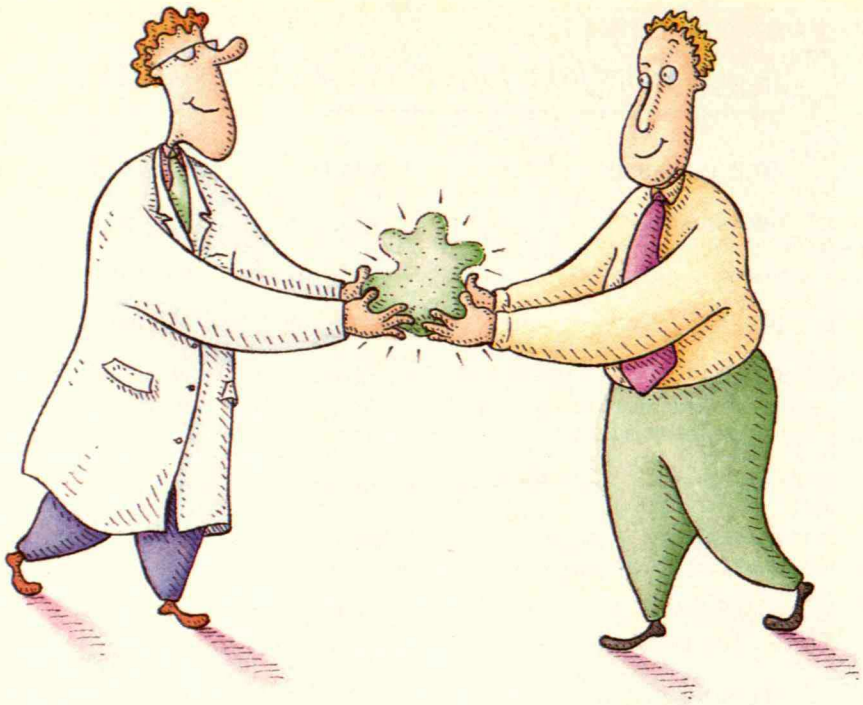
Materials suppliers in most industries do have applications teams that can serve as liaisons with product designers. Plastics companies in particular excel in helping product designers choose which plastic best suits their application, because this strategy helps them compete with steel and aluminum manufacturers. In most industries, however, applications teams work only with the largest clients, such as the automotive industry; and in most firms, those teams involve only a handful of engineers compared with the thousands involved in research. To bring their innovations to market more quickly, materials suppliers should devote a much larger share of their resources to creating and supporting applications teams, and should ensure that these teams work closely with companies in smaller markets as well as large ones.

Both the materials supplier and the user must also be more willing to share proprietary information, with the supplier describing the strengths and weaknesses of the material and the user discussing in detail plans and strategies for product development. A high level of trust is needed to offset the risks of sharing such sensitive information. Some firms might rely on a handshake between CEOs; others might require a strongly worded confidentiality agreement. Whatever route they take, in the end, both suppliers and users stand to gain by negotiating this kind of partnership.

Twenty years from Invention to Commercialization

MATERIALS TECHNOLOGY	INVENTION	WIDESPREAD COMMERCIALIZATION
VULCANIZED RUBBER	1839	late 1850s
LOW-COST ALUMINUM	1886	early 1900s
TEFLON	1938	early 1960s
TITANIUM (used as a structural material in the aerospace industry)	mid 1940s	mid 1960s
VELCRO	early 1950s	early 1970s
POLYCARBONATE (used in bulletproof "glass")	1953	about 1970
GALLIUM ARSENIDE (used in semiconductors)	mid-1960s	mid-1980s
DIAMOND-LIKE THIN FILMS (used to coat hard disk drives)	early 1970s	early 1990s
AMORPHOUS SOFT MAGNETIC MATERIALS (used in transformers)	early 1970s	early 1990s

Although the time lag between invention of a material and common use is typically two decades, companies can take a number of steps to reduce the barriers to faster commercialization.



Materials suppliers and users need to create partnerships that will permit them to share the risks—and the profits—of bringing new products to market.

Building Production Capacity

The fact that new materials are usually produced in limited quantities also slows their adoption. In large industries, such as the automotive industry, the volume requirements of even a modest-scale adoption may be several times greater than the suppliers' production capacity. The problem of low capacity may be amplified by mutual mistrust. Product designers are wary of incorporating new materials into their processes unless they are sure there will be an adequate supply, while suppliers hesitate to invest in major new facilities unless there is a guaranteed market for the new material.

Moreover, while the potential for monopolistic profits is exactly what drives suppliers to develop new materials, it can deter their adoption. Adopters do not want to be held hostage by suppliers who may not keep prices stable over the life of the product. As long as a substitute is available, even if it is inferior, designers will avoid the risk of selecting a material that is priced monopolistically; they will delay introduction of the new material until the monopoly afforded by patent protection expires.

Large-scale users commonly solve this problem by requiring multiple suppliers. But this strategy can create excess capacity in the new industry. If each plant must produce, say, a million pounds of a given material in order to operate efficiently, suppliers may be left with unused capacity. Requiring multiple suppliers can also discourage materials development, because investors may decide that the profit potential is too low to justify the risk of the venture.

To overcome this problem, materials suppliers and users may need to create partnerships or joint ventures that will permit them to share the risks—and the profits—of bringing new products to market. With a commitment in hand, materials developers can go to the bank and get the backing they need to increase production levels. Users in turn can be assured of an adequate supply and stable prices. To create these kinds of agreements, however, firms must achieve a level of trust and commitment that has historically been lacking among U.S. companies. Until now, they have had little incentive to combine their efforts; but as the time, costs, and risks of bringing materials to market have increased, companies are beginning to find that the rewards of cooperation far outweigh the costs.

Inflexible Codes and Standards

Another barrier to the commercialization of new materials is the lack of flexibility in the codes and standards governing the construction of buildings, bridges, pressure vessels, transportation systems, and the like. These guidelines are usually written by committees of professional or trade associations, such as the American Society of Mechanical Engineers (ASME), which writes codes for pressure vessels, or the American Petroleum Institute, which sets

standards for pipelines. The National Institute of Standards and Technology, part of the Department of Commerce, performs research to generate performance and safety data. State and local governments then use these codes as the basis for their own regulations.

Many codes and standards, particularly those formulated in the first half of the century, specify the kinds of materials that can be used in each setting. New materials are automatically excluded from use. Most building codes, for example, often specify copper rather than aluminum electrical conductors for household wiring—in part because of safety problems that occurred 25 years ago when contractors and builders began to substitute aluminum for copper without redesigning the connectors.

Trade associations have recently begun to establish codes and standards based on product performance rather than specific materials. For instance, plumbing codes for new piping may specify criteria for properties such as corrosion resistance, rigidity, and the ability to withstand pressure. This allows suppliers to choose among a variety of materials—copper, plastic, and galvanized steel—that meet these requirements.

It can take a long time—and a lot of money—for manufacturers to accumulate enough experience to demonstrate that new materials can meet performance-based criteria. In some cases, the new codes create a catch-22: we can't use the material until we have generated the performance data, but we can't generate the performance data because we can't use the material. As a result, contractors and builders continue to use otherwise inferior materials simply because they have more experience with them.

One factor driving up the costs of experimenting with new materials is risk assessment. The Boiler and Pressure Vessel Code is an excellent example. Written by ASME and adopted, with some variations, in all 50 states, the code governs machinery used in any process that involves gases or liquids operating under pressure: electricity generated as water is turned to steam, for instance, or many chemical processes. The code was formulated during the early part of the century to prevent catastrophic failures and explosions. Contained in many volumes occupying several feet of shelf space, it spells out in detail the types of materials that may be used and the performance specifications a new material must meet. The materials specifications are nearly the same as they were 50 years ago, despite the fact that much stronger, more fracture-resistant steels are now available. This is because the performance criteria are so stringent that it would take tens of millions of dollars to prove that a new material could perform equally well. No one company can afford to underwrite such extensive tests. But the costs of failure are so high that no one wants to risk changing the standards.

To lower the cost of adopting new materials, codes specifying performance criteria for new materials should recognize different categories of risk. The code for pipeline construction already does this. A natural gas pipeline that passes through a densely populated area must meet more stringent performance standards than one located in open land. Similarly, a large pressure vessel located in a highly populated area should be built with a high degree of conservatism, but a smaller vessel containing a less hazardous substance (like water or oil, rather than natural gas) located far from most people or buildings should be allowed to incorporate new designs and materials. Instead of serving as a barrier to innovation, properly written codes and standards can encourage it.

It will take a long time to develop more flexible codes and standards, since trade associations review them on a case-by-case basis. Firms that develop new materials can speed their acceptance by assigning representatives to join the relevant trade association committees and lobby for changes that will give builders and contractors greater freedom to choose among materials.

Lowering Production Costs

Even if all other barriers can be overcome, a new material must be cost-effective to produce if it is going to be widely used. But production processes are likely to be inefficient in the early stages of the learning curve and yields relatively low. This forces developers to keep prices high to recoup their investment.

The industries most likely to lead in introducing new materials are those that can demonstrate the greatest savings by doing so. For example, the aerospace and aircraft industries have successfully adopted high-performance, lightweight composite materials, some of which are very expensive. They can afford to do so because the value of weight saved over the life of a spacecraft can be $20,000 per pound; in commercial aircraft it is $200 per pound. By contrast, in an automobile the equivalent figure is $2 per pound. (Indeed, most of the heaviest components in a modern automobile are composed of materials whose cost in bulk form is one dollar per pound or less.) Thus it is unlikely that the automotive industry will benefit by using these expensive lightweight materials until the cost comes down. It is not that the aerospace industry is necessarily more progressive than the automotive industry; it's just that those companies can afford to pay a higher price for improved performance.

In rare cases, high-volume users have even stepped in to bring down the cost of new materials. When General Motors Research Labs invented iron-neodymium-boron magnets, GM managers were eager to use these

high-strength, permanent magnets in small automobile motors, such as those that operate windshield wipers and power windows. There may be 30 to 40 such motors in one vehicle; since a smaller magnet could be used to generate the necessary field, these motors could be made smaller, lighter, and more efficient. But the price of metallic neodymium was prohibitively high—not because the ore was rare, but just because the metal had never had any significant commercial utility. To commercialize its own invention, GM researchers set out to find ways to process neodymium ore more cheaply. When it became apparent that these efforts were bearing fruit—GM actually invented and patented a process for refining neodymium ore into metal—existing neodymium processors swiftly lowered their prices. As a result, GM postponed its plans to produce its own supply. But by achieving its intended result—lowering the price—the automaker significantly reduced the usual 20-year lag from conception to widespread commercial use of a new material. GM is now threatening to use the same strategy to lower the price of magnesium, a very lightweight substitute for aluminum or plastic.

The longer it takes to bring down the costs of a new material, the slower the commercial payoff will be—and the less time will be left before the patent on the invention expires. The solution is for companies to invest as much (or more) in the process for producing a new material as in developing it—and to control the process technology, rather than the product technology.

A successful example is Lincoln Electric Co., the world's largest manufacturer of welding electrodes—the metal wires through which current passes to create an arc of electricity. In the 1950s, the company developed a steel welding electrode that did not have to be surrounded by a shield of argon or carbon dioxide to prevent the metal from reacting with nitrogen in the air. The firm also developed a very efficient process for producing this self-shielding electrode. The company patented the product and held the process technology as a trade secret. While its competitors soon copied the product and engineered around the patent protection, the proprietary process enabled Lincoln Electric to sell its electrode at prices below competitors' production costs. Today, though the electrode's patent has expired, Lincoln Electric still enjoys an effective monopoly. It is the process technology that makes this product a winner for them.

Investment in process technologies by both government and industry could speed commercialization by increasing yields, improving reliability, and reducing the cost of new materials. But numerous studies show that U.S. industry spends far too little on process-oriented research: 70 percent of R&D funding goes to product development (including basic research) and 30 percent to process development. In Japan, these percentages are reversed.

Much of the emphasis on product development comes from the U.S. government, which funds about half of the nation's R&D. Ninety-five percent of federal R&D funding is devoted to product development. In recent years, however, the government has begun to recognize the importance of investing more in process technologies.

For instance, there is some evidence of a shifting emphasis toward process development in the new Advanced Technology Program (ATP) under the Department of Commerce. A public venture-capital fund for private business, ATP represents the fastest-growing segment of the federal research budget. The program has always required that participating companies provide a commercialization plan. Initially, this provision was interpreted to mean a marketing plan for a new product. More recently, the government has encouraged companies to develop new manufacturing processes and show how they plan to implement them. This is a small but potentially significant step toward redressing the imbalance between product- and process-oriented research funding.

Beyond the Barriers

There are limits to how much companies can do to speed the process of commercializing new materials. For instance, the length of the investment cycle in certain industries may delay large-scale production of a new material. This problem is particularly common in industries such as steel and chemicals, where the costs of a unit of production capacity are high and the productive lifetime of the equipment is several decades or greater. One cannot discard a long-term investment merely because a new alternative becomes available.

However, most of the barriers delaying commercialization of new materials can be overcome. And not every barrier will exist for every product. If managers begin to tackle potential obstacles early in the development process, they may be able to cut the time frame for commercialization of materials in half. But such a change is unlikely to occur overnight: managers have to develop the skills and mechanisms for speeding commercialization. Meanwhile, they must recognize the potential 20-year time frame and plan their research and investment strategy accordingly.

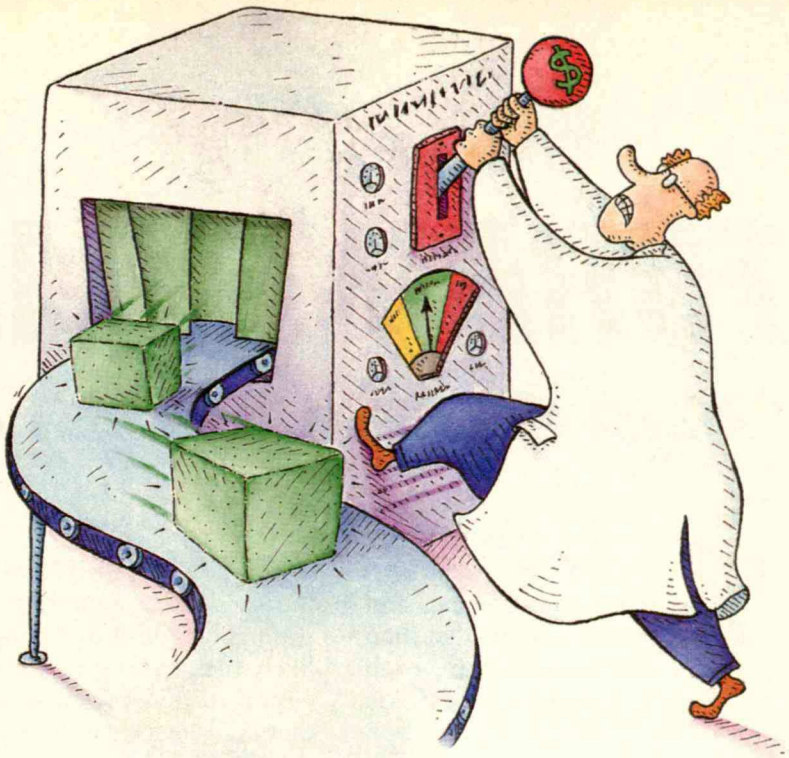
Since process technology is likely to be the key to a company's success in commercializing new materials, companies need to reevaluate the time and money they spend on developing new materials. In particular, they need to foster cooperative research in the early stages of materials development. This will free up the resources they need to focus on process research later in the game.

Competition in the early stages of materials research

is duplicative and dysfunctional. Experience has shown that, given the 20-year window for commercializing new materials, no one will establish an insurmountable lead by running ahead of the pack at that stage of the race. Instead, it makes sense for companies to begin by sharing information so that everyone can progress faster.

Leadership in this kind of early intra-industry cooperation has to come from the top. Government-initiated projects like Sematech, a consortium aimed to improve process technology for manufacturing semiconductors, have already shown that firms that compete in the marketplace can cooperate in development. With half its funding from the military, Sematech has brought together a number of U.S. companies. Many were reluctant to commit their best people and resources and were unwilling to share proprietary information. Only after several years have managers come to realize that it is in their best interests to cooperate.

The government can also foster this more productive strategy by creating a climate that encourages rather than squelches international cooperation in materials research. Nearly every year, legislators in Congress introduce bills whose aim is essentially to classify government-funded research; the most recent was sponsored last year by Rep. John Dingell of Michigan. While no bill has yet been passed, funding agencies appear sensitive to potential criticism; there are direct or indirect pressures to restrict interaction among scientists from different countries.



Investment in process technologies by both government and industry could speed commercialization by increasing yields, improving reliability, and reducing the cost of new materials.

Government officials need to recognize that cooperative research augments a nation's investment—it does not squander it. The Council on Competitiveness recently found that the United States was behind or even with other countries in 18 of 21 key technologies. Clearly, American scientists need to tap a pool of knowledge that lies outside our borders. By participating in multinational joint research efforts, a company can maximize the return on its investment.

Finally, corporations must plan ahead to identify opportunities for developing a competitive advantage in their fields. Technology scouts—sophisticated scientists who can search the world for new ideas—can help at every stage of the research process. They can target knowledge for exchange with other researchers, find opportunities to form partnerships with other firms, identify the primary barriers to adoption of a new material, and lay the groundwork for commercialization. This information can help managers shape corporate strategy. AT&T and Corning used this approach when they joined forces to lay the foundations for the optical fiber industry: Corning commercialized the optical fibers, while AT&T developed lasers to send signals along them. AT&T scientists also helped Corning solve some problems with the process for making the fibers, recognizing that both corporations would profit from this knowledge.

In the past, most companies have tried to go it alone in developing and commercializing new materials. This strategy, however, is no longer effective: it is too slow, too expensive, and too unlikely to produce profitable results. Instead, companies must develop new mechanisms that foster cooperation in research, design, and strategic planning if society is to capture the benefits offered by new and advanced materials.

By
David
Gordon Wilson

TURBINE CARS

Major Contender, Bumpy Road

TODAY'S AUTOMOBILES ARE safer, quieter, longer lasting, less polluting, and less greedy for fuel than ever before. Still, each year, U.S. motor vehicles release around 350 million tons of carbon into the atmosphere in the form of carbon monoxide and carbon dioxide. And improvements to the conventional spark-ignition engine are following the law of diminishing returns: gains have become incremental and are costing more to attain. To reduce automotive pollution, we need to consider a radical change of propulsion system.

Most of the work on alternative engine technologies has focused on electric vehicles, powered either by batteries or fuel cells. But both systems have serious drawbacks. Electric batteries available in the foreseeable future will be large, heavy, and short-lived, requiring replacement after only about two years. The processes used to manufacture and recycle these batteries are hazardous and polluting. Battery-electric vehicles are also less efficient than those with spark-ignition engines, and when fossil-fueled generators are used to produce the electricity that charges the batteries, the net result is an increase in the production of CO_2.

Fuel cells, used for many years on spacecraft, have long-term promise and high efficiencies (*see "The Clean Machine," TR April 1994, page 20*). But fuel cells remain expensive, and producing and distributing the most likely fuel, hydrogen, will require an entirely different infrastructure than that in place for gasoline.

We should be looking hard, therefore, at another option: the gas turbine engine. Compared with spark ignition engines, gas turbine engines weigh less, last longer, and break down less often. Gas turbine engines can attain thermal efficiencies in the mid-40s; piston engine efficiencies are in the high-20s and unlikely to go much higher. The gas turbine engine excels from an emissions standpoint: it is the only automotive engine technology to have met the most stringent limits tentatively set by the Environmental Protection Agency. Indeed, gas turbines with no exhaust treatment whatsoever have lower emissions than spark ignition and compression ignition engines with the best treatment available. And unlike the spark ignition engine, which has stringent requirements for fuel, the gas turbine can burn a variety of fuels, including not only gasoline but also diesel, home-heating oil,

Illustration by Terry Widener


THE TECHNOLOGY OF CHOICE FOR DRIVING JET AIRCRAFT AND RUNNING ELECTRICAL POWER PLANTS WOULD MAKE CARS CLEANER AND MORE EFFICIENT.
wiener

and almost any other liquid or gaseous fuel.

The gas turbine vehicle has some clear advantages over fuel cells and batteries, too. Gas turbines are compact sources of power, capable of delivering 3–4 kilowatts per kilogram, as opposed to the less than 1.5 kilowatts per kilogram from a fuel-cell and 0.5–1.0 kilowatts per kilogram from a battery system of a size sufficient to give an acceptable range. With improvements that are well within our grasp, a midsized gas turbine car could achieve 80 miles per gallon.

Gas turbine technology is not new. In the 1950s, the gas turbine engine displaced spark-ignition engines in all but small, private aircraft because of these engines' much lower weight. In the 1970s and 1980s, most naval vessels of the destroyer and cruiser classes were re-engined with "aeroderivative" gas turbines, which by then were even more compact and efficient. In the last decade, most new electrical-generating capacity has been in the form of "combined cycle" gas turbines (i.e., gas turbines and steam turbines). Because the technology is mature, gas turbines are potentially much less expensive than the more exotic alternatives. What's more, gas turbine engines are better matched to the existing infrastructure of filling stations and repair shops.

Several past commissions, including the National Academy of Sciences Committee on Motor Vehicles Emissions in 1973, have concluded that gas turbines are the best alternative to the standard auto engine. Both the Department of Energy and the National Aeronautics and Space Administration (NASA) have been sponsoring research to produce a gas turbine engine for an automobile. Unfortunately, much of this work has been misdirected. But if we undertake a midcourse correction, the prospects for gas turbine cars will brighten. Some simple and well-understood design changes should make future gas turbines less expensive to manufacture and more efficient to operate than today's versions.

A Simple Engine

Gas turbine and spark ignition engines have basic similarities. In each, the engine takes in air, compresses it, heats it by burning fuel, and finally expands the gases back to near atmospheric pressure. In a piston engine, these processes take place sequentially in the same component: the cylinder. In the gas turbine, the same processes occur continuously in specialized, and therefore more efficient, components. For example, gas turbine engines boast compression efficiency in the mid-80s, as opposed to the low 70s typical in a spark ignition engine. (Compression efficiency is the theoretically minimum power required for compression divided by the actual power.)

The basic gas turbine is a simple machine. A shaft has a compressor at one end, similar to the fan in a vacuum cleaner, which draws in atmospheric air. A duct carries this compressed air to a turbine—rather like a farmer's windmill—that is mounted at the other end of the shaft. Fuel is injected into the combustion chamber, an enlarged section of the duct, and lit. The hot gases expand through the turbine and force it to spin vigorously. The shaft speeds up, delivering power both to drive the compressor, which continuously sucks in outside air, and to the car's drive train.

The continuous flow of the gas turbine means that a far smaller engine can produce the same power as the intermittent-flow piston engine. The gas turbine's continuous operation has other consequences—not all of them favorable. In a spark ignition engine, for example, the intermittent inflow of air keeps the cylinder walls relatively cool and the engine can be built of low-cost materials like cast iron. But the components of a gas turbine engine must be able to withstand very high temperatures; in today's engines, the turbine nozzles and blades are made of advanced high-temperature metals.

To help keep the temperature of the gases low enough to prevent the ducts and turbine from melting, gas turbine engines draw in large amounts of excess air. While a drag on efficiency, this lowered temperature is helpful because it reduces the production of nitrogen oxides. The gas turbine's use of large amounts of excess air also lowers emissions of hydrocarbon and carbon monoxide virtually to zero.

Making a Good Thing Better

Although present gas turbine engines are already efficient and low-polluting machines, substantial avenues for improvement exist.

One drain on the efficiency of gas turbine engines is leakage—in an engine that has been operating for many hours, some 4 to 14 percent of the flow of compressed air escapes through leaks from the seals around the regenerator. This, more than any other single technical problem, has held back the automotive gas turbine. With further advances in regenerator technology, gas turbine engines could offer a significant improvement over the spark ignition engine and other competitors.

A technology just developed by our lab should

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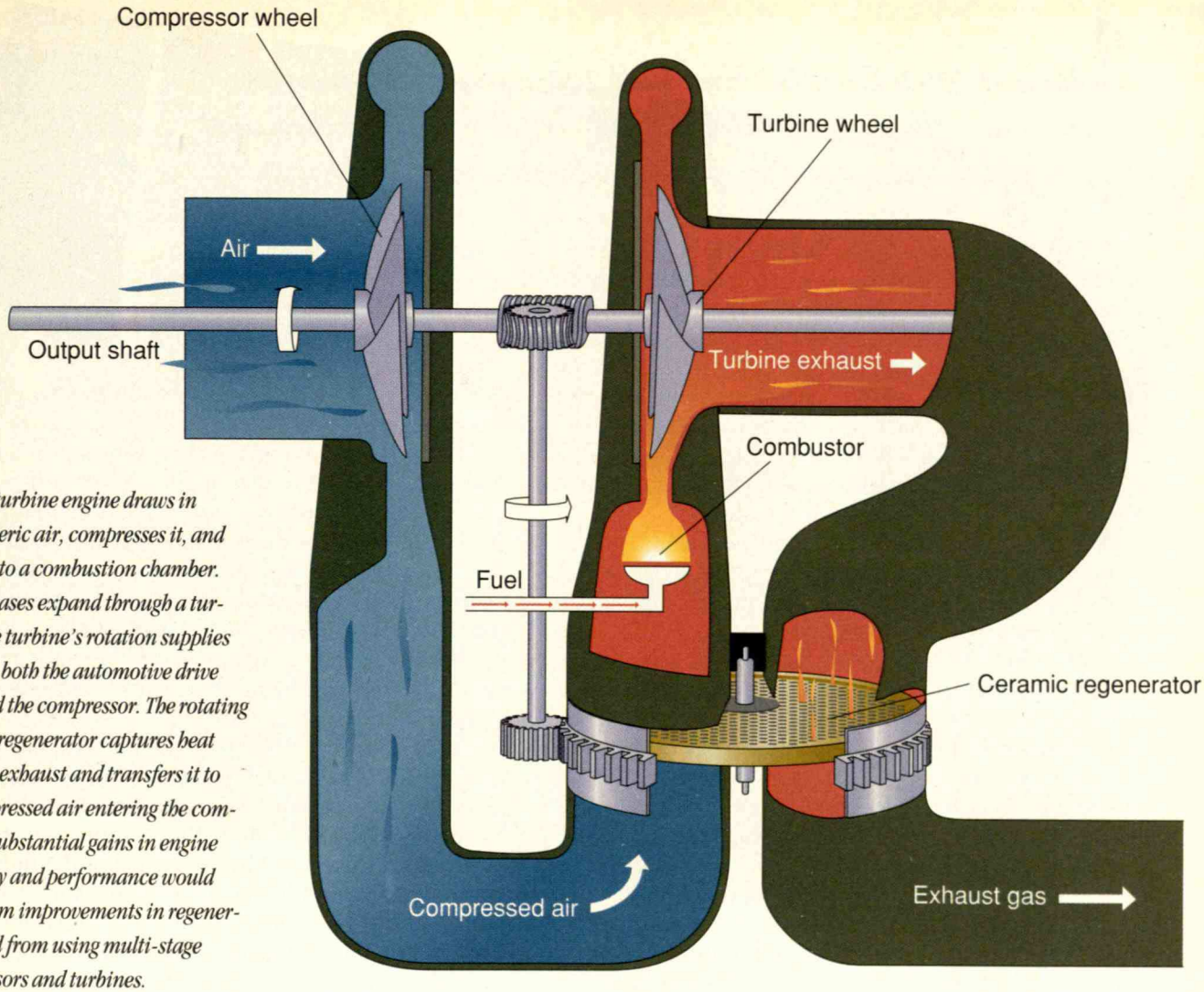


A gas turbine engine draws in atmospheric air, compresses it, and passes it to a combustion chamber. The hot gases expand through a turbine. The turbine's rotation supplies power to both the automotive drive train and the compressor. The rotating ceramic regenerator captures heat from the exhaust and transfers it to the compressed air entering the combustor. Substantial gains in engine efficiency and performance would come from improvements in regenerators and from using multi-stage compressors and turbines.

greatly reduce regenerator wear and leakage. Present regenerators rotate steadily and slowly, at about 3 to 10 rpm, with the seals continually rubbing on the ceramic structure. In the new system, the disk rotates in small steps—perhaps 30 degrees—and then remains still. During this time of rest the seals are clamped to the matrix faces. Then, just before the next step, the seals are withdrawn about 50 microns to allow the disk to rotate another increment before reclamping. We believe that this technology, which we are now testing, will reduce the seal leakage to between 1 and 2 percent and almost eliminate seal and matrix wear. As a result, the automotive gas turbine would further reduce its fuel consumption, its life would increase, and maintenance requirements would decrease.

Another way to improve the efficiency of gas turbine engines is to recover some of the heat in the exhaust gases and transfer it to the compressed air before it flows into the combustion chamber. This process lowers the amount of heat that must be deposited in the incoming air.

The type of heat exchanger best suited for a gas turbine engine is a regenerator—a thick ceramic disk, honeycombed with tiny passages. When the regenerator disk rotates, these passages are alternately immersed in the hot gas, where they absorb heat, and then plunged into the cooler gas, to which the heat is given up.

Although pioneered by Chrysler and Corning, the ceramic rotary regenerator was given its major impetus by Noel Penny of Britain's Rover Cars. Penny put a regenerator on a car competing in the 1965 Le Mans 24-hour race. Despite serious damage to the compressor and regenerator disk from dirt entering the unfiltered air intake early in the race, the car finished in tenth place; most cars don't finish at all. This impressive performance convinced designers that ceramics were robust enough to use in regenerators and to abandon stainless-steel versions.

CHART: MICHAEL PRENDERGAST DESIGN

In the mid-1960s Chrysler Corp. built 200 gas turbine cars for consumer testing. Thirty years later Detroit has yet to mass-produce such cars, and U.S. automakers lag Japan in developing the technology.

Unlike the efficiencies of the compressor and turbine, which reach apparently unbreachable limits at, for engines of this size, around 85–90 percent, there is no fundamental ceiling on regenerator "effectiveness"—the portion of available heat that is transferred from the exhaust gas. Although designers of automotive turbines generally size the regenerator to recover 90–93 percent of this heat, it is possible to increase effectiveness to 97–98 percent merely by increasing the thickness, and perhaps the diameter, of the rotating disk.

Raising the regenerator effectiveness leads directly to higher overall efficiency. The best efficiency of a spark ignition engine is in the range of 27 percent. A gas turbine using a 90 percent effectiveness regenerator has a peak efficiency of 33 percent. Pushing the regenerator effectiveness up to 97.5 percent would yield thermal efficiency of more than 42 percent, meaning even greater fuel efficiency and lower carbon emissions.

Perhaps more important, a higher-effectiveness regenerator lowers the burden on the compressor. In an engine containing a typical regenerator—that is, one with an effectiveness of 90 percent—top efficiency is reached when the pressure of the intake air is increased by a factor of almost 6 to 1. Boosting the effectiveness to about 98 percent lowers this optimum pressure ratio to below 3 to 1. This reduction in compression ratio permits the compressor to spin more slowly, reducing the stress on the compressor blades. The lower outlet air pressure gives a lower air density, which means that the blades can be longer, which in turn increases the compressor's efficiency by reducing the effect of the clearance between the blade tips and the housing. Operating at lower pressures also slows the flow of air through the compressor to subsonic speeds, further reducing losses.

To lower the stresses and velocities in the compressor even more, we could build an engine in which the compression took place not in one rotor but with three in series, all mounted on one shaft. The pressure ratio per stage would then drop by more than half, yielding dramatic reductions in the compressor's maximum stress as well as in the speed of airflow. Again, this reduced speed permits longer blades and therefore more efficient operation.

A three-stage compressor would also aid efficiency in another way: by recovering energy that single-stage compressors cannot. The outflow from one compressor rotor becomes the inflow for the next, and the outflow from the second becomes the inflow for the third. This configuration makes the greatest possible use of the exiting gas's kinetic energy, which, unlike heat energy, is of no use in the regenerator and is therefore completely squandered. A three-stage compressor wastes one-third as much kinetic energy in this way as a single-stage compressor.

Besides improving a gas turbine's efficiency, the lower pressure ratio also opens up a mouth-watering possibility. Compressor rotors are now made of cast steel or aluminum. But the large reduction in stresses that follows from the slower rotation would make it possible to injection-mold the rotors from a fiber-reinforced, high-duty resin. Any of several lightweight composite materials—for instance, polyphenylene sulfide, polyetheretherketone, or polyethersulfone—could substitute for aluminum.

This change would yield several benefits. The surface finish and accuracy of the composites are likely to be better than for the cast aluminum, reducing friction as the air passes through the compressor and thus improving efficiency. Moreover, use of the lightweight composites would lower the compressor's rotational inertia and thus improve the engine's responsiveness. The overall gain in fuel efficiency over existing experimental gas turbines due to all these measures would be 50–90 percent, giving approximately a doubling in miles-per-gallon over today's cars with spark-ignition engines. The manufacturing cost of the compressor could be lowered by at least 50 percent.

History Unheeded

Even if designers of gas turbine engines adopt the innovations described thus far, the technology could still face serious problems. That's because makers of these engines have stuck with a design with a serious flaw that has been known for more than a century.

A turbine can be designed so that the hot gases leave the turbine nozzle either parallel to the axis of rotation (axially) or perpendicularly toward the axis of rotation (radially). The turbine engines built in the NASA–Department of Energy program use radial-flow turbines. These cost less to manufacture in small numbers than axial turbines, and their efficiency is acceptable.

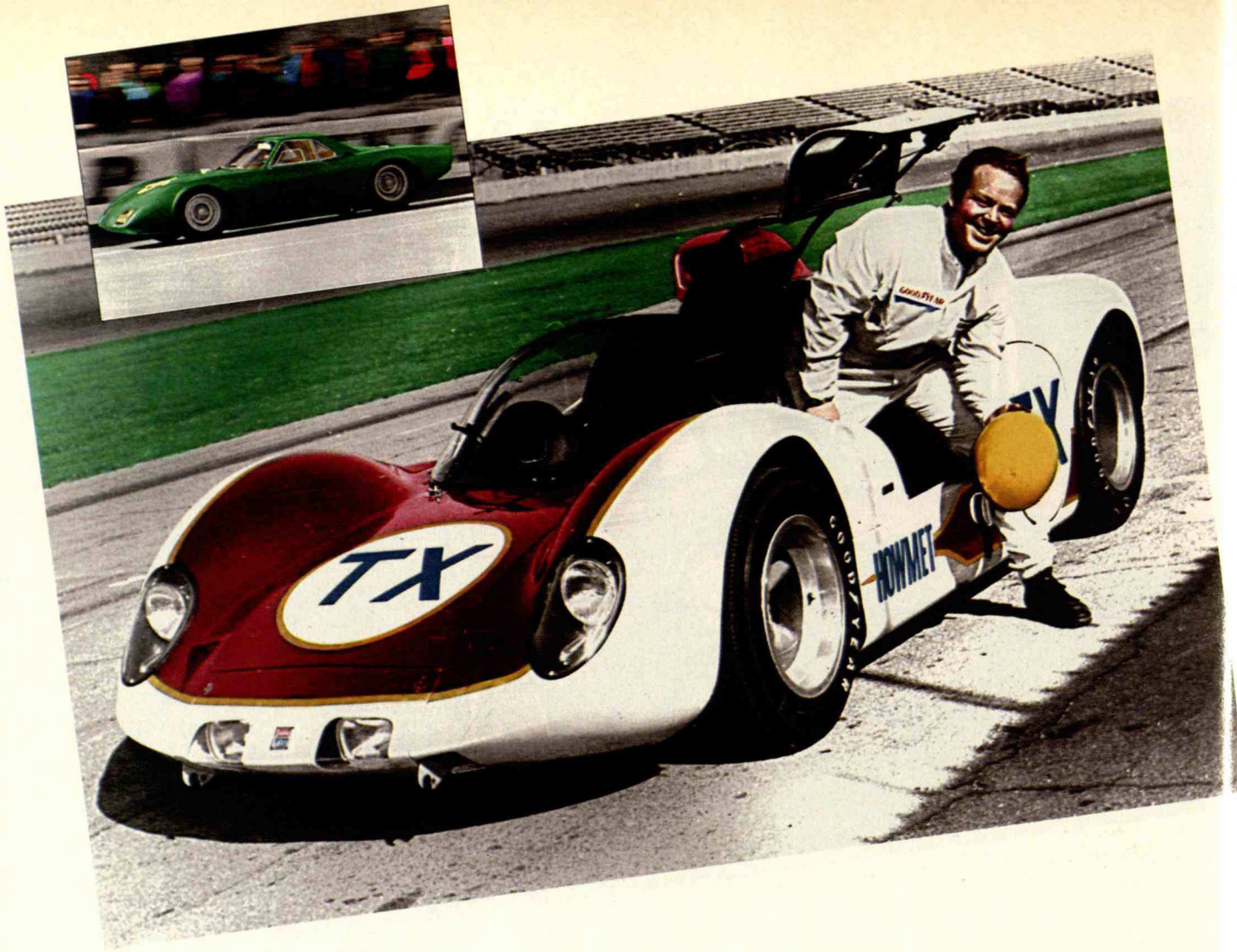
But radial-flow turbines have two flaws. One is a higher inertia because a more massive disk is required on which to mount the much longer blades. High inertia means the automobile engine is less responsive to sudden demands.

The second and more important flaw is that radial-inflow turbines cannot pass foreign matter. Dirt and other solid particles—anything other than gas—gets stuck in the turbine. That's because the turbine acts as a centrifuge; any particle more massive than the gas that carries it stays on the periphery, where it slams into one turbine blade after another. When the turbine is turning at full speed, the tip of the blade is traveling so fast and the resulting acceleration field is so intense that even single grains of sand cannot pass through the rotor. The particles bounce off the rotor blades on to the nozzle blades and back again—eventually knocking a larger particle off either the rotor or the nozzles. Destruction follows rapidly.

We have at least a century of history of unhappy experiences that should have warned those who chose this device. In 1889, the principal inventor of the turbine, Charles Parsons, switched from an axial design to a 13-stage radial-inflow steam turbine. This machine, called "Jumbo," ran sweetly at first—but by the end of an hour the power had dropped drastically, because the water droplets in the steam would not pass inward in the high-acceleration field and eroded the rotors and nozzles. More recently, contractors for NASA and the departments of Defense and Energy have experienced repeated failure with radial-inflow turbines. Radial-turbine blades and nozzles of a gas-turbine power unit built for the U.S. Air Force in the 1960s, for example, repeatedly eroded because the combustion chamber produced hard carbon bits that would not go through the turbine. Manufacturers of these turbines therefore take great care to exclude foreign matter during assembly and from the air and fuel flows—a quest that usually proves futile.

Axial turbines avoid both of the problems that plague radial-flow types. Axial designs are smaller, so the engine can be more responsive. And because the hot, compressed gas flows through the turbine parallel to the axis of rotation, it feels no centrifugal tug—dirt particles can pass straight through without eroding the machinery blading. A major advantage of axial-flow gas turbines is that they can be "multistaged": several turbines can be closely coupled so that the kinetic energy in the outlet flow of one turbine is efficiently used in the next. The best match to a three-stage centrifugal compressor is a three-stage, axial-flow turbine. One turbine drives the compressor, and the other two deliver power to the transmission and the car. The result would be a

PHOTOS: UPI/BETTMANN



more compact, longer-lived, and reliable engine than one using radial-flow turbines.

This is hardly a radical proposal. Gas turbine pioneer Parsons changed to axial turbines as early as 1890. More recently, one NASA contractor, Allison Engine Co., switched from radial-inflow turbines to axial turbines—and company researchers immediately achieved the first full-speed, full-temperature operation with ceramic rotors. DOE's advanced turbine-technology applications project aims to produce, by 1998, an engine that will operate for 3,500 hours at turbine-inlet gas temperatures of about 1,370° C.

Hot Enough for You?

Most of the advances in gas turbines since the power gas turbine and the jet engine were invented in the 1930s have come from operating at higher and higher temperatures. Automotive gas turbines will need to pursue this same course.

Through the 1930s and 1940s, designers could increase these temperatures because of two helpful technological trends. One is that metallurgists provided metals with ever higher "creep strength"—the ability to maintain their shape when subjected to prolonged mechanical stresses at high temperature. The second factor was the development of sophisticated air-cooling systems for turbine blades and disks. As a result, the turbine-inlet temperature of jet engines has risen from about 750° C in the mid-1950s up to 1,500° C today. Similar temperatures are feasible with the large, stationary, gas turbines that some electrical generating plants now use.

But automotive-size gas turbines cannot share in this improvement. The turbine blades in car-size gas turbine engines are too small to incorporate cooling passages. As a result, the maximum temperature of the gas entering the turbine has been restricted to about 1,000° C, which holds down efficiency. To use even that temperature, the material costs were prohibitive. Having a material that could withstand temperatures far higher than 1,000° C without cooling has always been a dream for the designers of small gas turbines.

Such high-temperature operation first became a distant possibility with the development, over the past 15 years, of a new class of ceramics. When these materials first came on the scene, forecasts said they would be dirt cheap. But the problems of operating in an environment that combined extremely high temperatures and accelerations (as high as three-quarters-of-a-million "g" at the tip of a turbine blade rotating at full

PHOTOS: UPI/BETTMANN

With their muscular performance, gas turbine cars have long appealed to race-car drivers. In 1965, Rover's 145-horsepower auto (inset) competed in the LeMans 24-hour road race, and another turbine-powered vehicle (left) competed in the 1968 Continental Race.

speed) imposed demands that could not be met with low-cost ceramics produced by simple manufacturing methods. As a result, today's experimental ceramic turbines are more expensive than the metal turbines they replaced.

But ceramic costs could come down substantially if manufacturers could avoid expensive processing such as hot isostatic pressing. Further cost reductions could come from fabricating the turbine parts with processes developed in Japan for mass-producing silicon-nitride turbines for automobile turbochargers. (A turbocharger is a close cousin to a gas turbine engine. The engine's outrushing exhaust gas spins a turbine. The turbine is connected to a compressor, which raises the car's horsepower by packing more air into the cylinder before combustion.) Silicon-nitride ceramic turbochargers were introduced by Nissan in 1985; some six million of these units have been produced in the past five years. Indeed, the commercial manufacture of ceramic turbochargers lends credence to the view that gas turbine engines can be economically mass-produced.

Becoming a Contender

What will it take for gas turbines to take over the roads as they have the skies, seas, and, to a growing extent, electrical power plants? We can describe generally an engine capable of such conquest. Both the compressor and turbine would consist of multiple stages. The pressure ratio would be low. Compressor blades would be made from injection-molded, fiber-reinforced composite, while the compressor, turbine rotor, combustor, and turbine housings would be made of ceramic. A ceramic regenerator would recover heat from the compressed gas, reducing the amount of fuel that must be burned. Such an engine would be outstandingly responsive, capable of the quick acceleration that drivers have come to expect.

Still, the gas-turbine engine will not find quick or easy acceptance. Society has made a huge investment over the past 100 years in the spark-ignition engine, and it is manufactured at astonishingly low cost and, in general, performs superbly. The real cost of gasoline, adjusted for inflation, is at or close to an all-time low. Thus even an 80-mile-per-gallon gas turbine car would offer only a moderate economic advantage over conventional vehicles, many of which now deliver 30 to 40 mpg. In the near term, gas turbine engines make sense for some niche markets, such as large trucks and buses. Such large vehicles now must use diesel engines; compared with diesels, gas turbines offer greatly reduced emissions, lower noise, lighter weight, and lower maintenance requirements. But until demand is large enough to justify mass production, unit costs will be high.

Because of this uncertainty, none of the Big Three U.S. automakers are pursuing gas turbine technology with much vigor. Chrysler, which pioneered the technology and fielded 200 gas turbine cars in the mid-1960s, has dropped its effort. Gas turbine activities at Ford and General Motors, which were never as active as Chrysler to begin with, are principally limited to programs funded by the taxpayer. The main action in developing gas turbine engines has shifted to Japan, where the government is sponsoring a major R&D effort that includes participation by Toyota, Mitsubishi, and Nissan.

While today's market is unfriendly to gas turbine cars, the situation will change. Sooner or later, for example, the Russians will cease selling their oil at any price that will give them hard currency, and when that happens, world prices will rise, possibly sharply. Air pollution is worsening in most places, despite strenuous efforts to limit it.

The government is bound to set far more stringent emission and fuel-consumption limits or, more sensibly, to tax emissions and fuels. At some point, the cleanliness, high efficiency, low weight, and smoothness of the gas turbine will make the switch worthwhile.

The key is the reduction in manufacturing cost. Here the concept of multistage compressors molded in fiber-reinforced resin, and of a multistage axial-flow turbine formed in low-cost ceramic, could produce a breakthrough when coupled with a low-leakage, low-wear regenerative heat exchanger. An intensive program could yield a radical new engine such as this in two years—for trucks, buses, or automobiles.

What is needed to bring about a change to this more desirable engine? The fastest route would be for governments to make drivers bear a greater proportion of the "hidden" costs of driving. In "The Going Rate: What It Really Costs to Drive," James J. Mackenzie and his coauthors at the World Resources Institute point out that "American motorists are being subsidized to the tune of about $300 billion a year." If some of this were billed there would be a rapid shift to the gas turbine because of its greatly reduced environmental-impact costs alone.

All that is needed, then, is your sharpened pencils and fax machines to encourage governments to practice real-world economics. ■

My Shopping Trip with André

By Lester Lave, Tse-Sung Wu, Chris Hendrickson, and Francis McMichael

In the spirit of Louis Malle's film *My Dinner with André*, in which the revelations of a worldly raconteur continually cause his naive companion's jaw to drop, we present two comparable players wandering the supermarket aisles. Our Professor André is fictional, a composite of what the authors deem the best current thinking of food scientists and energy analysts. As he and the "concerned consumer" tour the store, they examine the modern shopper's choices and their ramifications. As in the film, André's audience learns that things are not always what they seem.

—*THE EDITORS*

CONCERNED CONSUMER: Thank you so much for agreeing to answer my questions, Professor André, as we walk through this supermarket. I'm terribly concerned about the extravagance and wastefulness of so much of what I see in these aisles, and I'm hoping you can set me straight on what's good and what's bad for the environment as well as my pocketbook.

ANDRÉ: Fine. How about starting with the prosaic biscuit? Do you like hot biscuits just out of the oven?

CC: Love 'em.

ANDRÉ: So let's talk biscuits. The basic issue is: How much convenience do you want with your biscuits? Consumers can make them from the raw ingredients of flour, milk, butter, and baking powder; we can buy a packaged mix; or we can buy premixed dough. As convenience increases, so does cost. It costs about 13 cents if you make six biscuits from scratch, 18 cents if you make them from a mix, and 55 cents if you use premixed dough. In other words, measuring the ingredients instead of using a mix saves you 5 cents. Measuring and mixing the ingredients, rolling out the dough and cutting it, and washing the mixing bowl and rolling pin save you 42 cents.

Biscuits from premixed dough cost you more than four times as much as making them from scratch. But that is not expensive when you consider your time. I figure that going from the least-convenient to the most-convenient product saves you about 20 minutes. Given the 42-cent additional cost, that amounts to $1.26 cents per hour of your time.

Similar comparisons apply to many

PHOTOGRAPHS BY STU ROSNER

Special thanks to Ronnie and his staff at Savenor's Market

Convenience foods cost several times as much as foods prepared from scratch. But the price is usually not high when you consider the value of your time.

other items—pancakes, for example. You can make them from scratch, from a mix, or from premixed batter; you can even buy cooked, frozen pancakes to warm in your toaster. If you make four pancakes, starting from raw ingredients costs you about 16 cents, the mix costs you 25 cents, the batter costs you 47 cents, and the frozen pancakes cost you 77 cents. Those four frozen pancakes cost you almost five times as much as making them from scratch.

But are you willing to pay 9 cents to avoid the effort of looking up a recipe and measuring the ingredients? Is it worth another 22 cents not to labor at mixing the batter (and then cleaning the mixing bowl)? Would you pay 30 cents more to forgo frying the pancakes and then cleaning the pan? Saving 61 cents will require at least 30 minutes of mixing, cooking, and cleaning up—about $1.22 cents per hour.

CC: I think that my time is more valuable than that. But I like to cook, and I feel good when I prepare food for my family.

ANDRÉ: Then you should make biscuits, pancakes, whatever, from scratch. But no one should condemn a consumer who does not like to cook or is very busy. It is perfectly reasonable to decide that your time is worth more than a dollar and a quarter or so per hour.

CC: What about the food-quality implications of convenience? I don't like the taste of frozen pancakes.

ANDRÉ: Quality is important. You will reject *some* convenience foods because of taste. But Americans increasingly prefer them. Who would have imagined single-serving "coffee bags," for example, before the 1990s?

CC: With more and more people opting for convenience, it must amount to big business in the United States.

ANDRÉ: And how! I estimate that an average of 75 cents out of every dollar spent on supermarket foods is spent on convenience. That is, the farmer typically receives only about 25 cents. For example, farmers get 34 cents out of every dollar spent on dairy products and 30 cents for meats. But farmers receive just 8 cents for bakery and grain products.

CC: No wonder farmers are going bankrupt. Consumers should try to channel most of their food dollar right to the source.

ANDRÉ: You could do that—by purchasing wheat directly from the farmer, for example, and at the bargain rate of about 10 cents per pound. Of course, you'd have to store the wheat and keep it away from pests. And you'd have to grind it into flour, just like your great grandmother did.

CC: Too much work.

ANDRÉ: Well, instead of buying wheat, you might go to the first level of convenience and buy 50-pound bags of wheat flour. They will cost you about 24 cents per pound.

CC: A 50-pound bag? I use only about 5 pounds of flour a month.

LESTER LAVE is a professor of economics at Carnegie Mellon University, TSE-SUNG WU is a doctoral student in the Department of Civil and Environmental Engineering, CHRIS HENDRICKSON is associate dean of the Carnegie Institute of Technology, and FRANCIS McMICHAEL is a professor of civil and environmental engineering. The authors are also associated with Carnegie Mellon's Department of Engineering and Public Policy.

ANDRÉ: Then most of the 50-pound bag would spoil—unless you also used a lot of pesticides. Perhaps you'd be better off buying 5-pound bags, at about 30 cents per pound.

CC: All right, I get the point. We have to pay for the convenience of not having to buy, store, protect, and process mass quantities. But surely most of the food dollar could go to the farmer for *non*-convenience foods such as unprocessed fruits and vegetables.

ANDRÉ: "Convenience" covers a lot more turf than you realize. For example, do you buy fruits and vegetables in the winter?

CC: Of course. I insist that my family has good nutrition. We eat the recommended five servings a day.

ANDRÉ: In the winter, most fruits and vegetables come from California, Florida, or even farther away—from Latin America and Australia, for example. About half the cost of this produce results from shipping, which usually entails some technological assist: produce spoils quickly if it isn't transported in expensive refrigerated trailers. And even refrigerated produce spoils in a few days. On average, 16 cents of a produce dollar goes to farmers, and it's amazing that they get *that* much.

CC: I don't see why you call all this "convenience." The transportation cost, say, of kiwi fruit is not convenience.

ANDRÉ: But it is. Otherwise, you'd have to go to New Zealand and buy the fruit yourself. In that case, kiwis would wind up costing you $25, not 25 cents, apiece. Instead, you essentially hire someone else to buy them, ship them, get them through customs, and transport them to the supermarket. Every one of these steps is not only a convenience to you but also gives you high-quality produce for a tiny fraction of what it would cost to buy it yourself. Similarly, imagine what the cost would be of driving to Kansas to buy bushels of wheat from the farmer.

CC: All right. I do like making pancakes from a handy mix, and I want the convenience of buying one kiwi at a time. But packaging really bothers me. Consumers waste a large fraction of their food dollar on packaging, much of which is not only superfluous but uses up precious resources and pollutes the environment. You're not going to defend packaging, are you?

ANDRÉ: Packaging, like convenience, generally gets a bad rap. In most cases, packaging saves money and improves food quality. For example, 40 years ago, meat was sold by shipping whole carcasses to the butcher shop. When you requested a sirloin steak, the butcher would cut it for you.

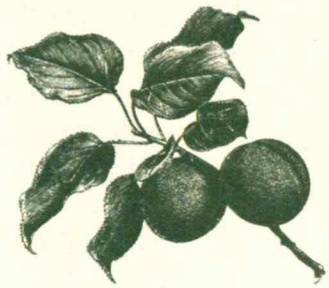
CC: That sounds wonderful! The meat was fresh and the butcher could give you advice about what to buy and how to cook it.

ANDRÉ: Unfortunately, the meat wasn't always fresh. The carcass stayed in the butcher shop until it was all sold or spoiled. Much of the meat was barely edible. It was expensive because butchers spent most of the day waiting for customers rather than cutting meat; their productivity was low.

Since the shop had to buy whole carcasses, it often didn't have what you wanted. For example, a butcher shop in a rich neighborhood tended to run out of steak and have too much hamburger, while a shop in a poor neighborhood had the opposite problem. If only a few people liked lamb, the shop couldn't afford to buy lamb carcasses.

When modern plastic packaging became available, carcasses could be cut and packed centrally. Meat could be shipped as "boxed meat," which is less expensive than transporting carcasses. Butchers are now highly productive, and the meat is sealed in tough, clear plastic.

One study estimates that the modern system lowers the price of beef by about 40 cents per pound. What's more, the quality of the meat is higher and the labeling is more accurate. Federal officials inspect both carcasses and individual cuts. If the package says this is a prime sirloin steak weighing 1.34 pounds, you can be pretty confident that all three facts are true. The carcass in the butcher shop probably was not inspected. Butchers could tell you whatever they wanted about the grade of



Even fruits and vegetables, especially during the winter, are "convenience" foods, transported safely from afar for a tiny fraction of what it would cost to obtain them yourself.

Packaging, like convenience, generally gets a bad rap. But in most cases, packaging saves money and improves food quality.

the meat and the cut; even the scale wasn't much help if it had a thumb on it as well as the steak.

Because meat is now packaged in transparent plastic film, the consumer can take a good look at it before purchasing it, carry the package without making a mess, and store the meat easily until it is needed.

CC: Perhaps plastic packaging is good for meat, but the elaborate packages I see for many supermarket products seem awfully frivolous.

ANDRÉ: Not necessarily. Pancake batter, biscuit dough, and single-serve items like beverages must be packaged to protect the food from rodents, insects, microbes, and other adverse influences. Ten 5-pound containers of flour require more packaging than one 50-pound container. And since you probably won't be using all of the contents at once, you want a package that can be resealed.

Frozen foods and ready-to-eat foods with long shelf lives generally need a great deal of protection. The packaging for cold cereals, for example, must protect them from pests, air, and moisture.

CC: All right, packaging is needed. But surely we can replace much of the plastic packaging with paper and do less harm to the environment.

ANDRÉ: Actually, about half of food makers' packaging expenditures are on paper and paperboard and the rest is evenly split between metal and plastic. Several studies have examined the environmental consequences of materials used for packaging. Looking at both the production of packaging and its disposal, the studies find that the raw materials, energy, and environmental discharges of pollutants are lower for a pound of paperboard than for a pound of plastic. However, only about one-sixth as much plastic as paper is needed on average to do a job. The net effect is that plastic uses fewer resources and pollutes the environment less than does paperboard per item packaged.

CC: But paperboard can be recycled and plastic can't.

ANDRÉ: Actually, both can be recycled, but little of either is recycled at present. Paper is probably easier to recycle because you don't have to worry about what type of paper it is. However, the value of waste paper for recycling is low; this is why little of it is recycled.

A large problem with recycling plastic film and foam is that there is so little plastic in each unit. You would have to collect hundreds of plastic wrappers to get a pound of material. That is labor-intensive and thus expensive. To recycle plastic effectively, the various types of plastic must be separated. That is also expensive. Plastics recycling could work well if ways could be found to collect the used packaging and separate the resin types cheaply.

CC: Even if paperboard weighs more, it degrades in the landfill and plastic doesn't. Since we are running out of landfills, we just can't afford to fill the space with plastic.

ANDRÉ: There has been a lot of discussion in the press about running out of landfills, but in fact there is no indication that this is happening. The price of putting materials into landfills has actually started to decline because the supply appears to exceed the demand.

In any case, the rate of decay of paper in landfills is very slow. One thousand paper bags weigh 134 pounds and form a 48-inch-high stack; the comparable figures for plastic bags are 25 pounds and 6 inches. Because paper weighs more than five times as much as plastic and has eight times the volume, it needs much more space in a landfill and requires more effort to get it there. After about 50 years in the Eastern United States and 500 in the Southwest, the paper will have decayed to the same volume as the plastic, which breaks down much more slowly. (Decay speed depends on region-specific variables such as moisture and temperature.)

If waste packaging is burned, the process can generate electricity. And in a modern incinerator, neither paper nor plastic should produce toxic emissions, though this depends on the pigments and plasticizers.

CC: Well, I think we should have less packaging so that we save resources for future generations.

ANDRÉ: Plastic packaging accounts for only a tiny proportion of the petroleum we use. If you are worried about future generations, you should turn your attention first to the major petroleum uses: gasoline, diesel fuel, and electricity generation.

Paper is a renewable resource and plastic from petroleum is not. However, plastics could be made from renewable resources such as plants.

CC: You sound like a Dr. Pangloss: everything is for the best in this best of all possible worlds. I don't see that today's resource use is sustainable. We need to do something and do it *now*.

ANDRÉ: I am not saying that current resource use is sustainable for the indefinite future. But the future is not as bleak as you might think. If some natural resource is scarce, its price rises, producers use less of it, and consumers buy less of the products that contain it. This works pretty well for raw materials. It doesn't work so well where costs of protecting the environment from the side effects of manufacturing a product are not embodied in its price.

Thus a difficult but important step would be "full-cost pricing," where the price of a product reflects the resources used and the outlays required to clean up environmental discharges. If prices reflected full social costs, consumers could make more informed choices. Today, consumers must sift through rumors based on inadequate data and very little analysis.

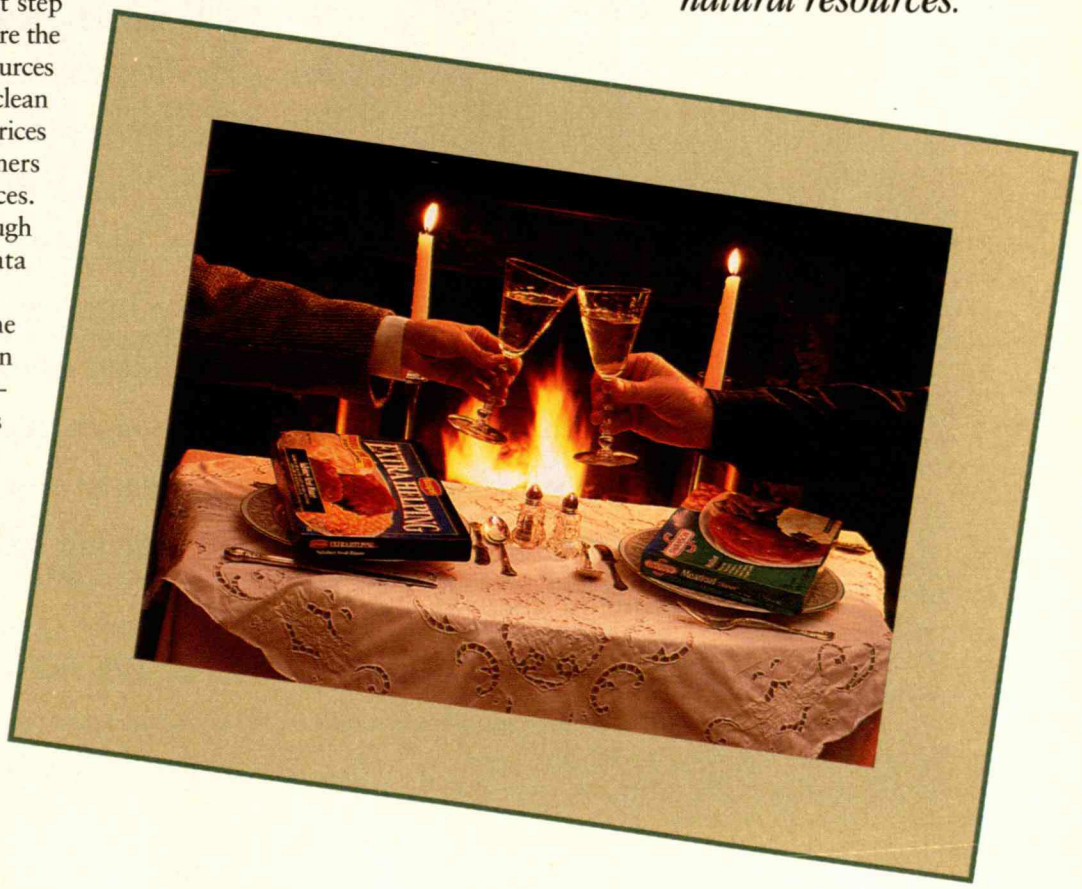
We also need to consider the entire life cycle of products when we talk about resource use. For example, packaging often reduces waste. When a carcass is cut in the butcher shop, a great deal of waste is generated. But when it is cut in the slaughterhouse, all of the fat and bone and other parts are used. By not shipping waste, we save energy and the cost of disposing of it in cities.

CC: You aren't suggesting that consumers do life-cycle analyses of all the products they might buy.

ANDRÉ: No. Those analyses could be done by government agencies (such as the U.S. Department of Agriculture, the Department of Energy, or the Environmental Protection Agency), consumer groups (the Consumer's Union, for example), or trade associations. The results could then be made available to consumers. Better still, the price of each product should reflect the results so consumers do not have to think about the environment every time they buy a package of frozen peas.

If you enjoy cooking and have the skills and time to achieve your own standards of taste, cooking meals from their basic ingredients is the way to go. But don't automatically assume that the alternative is too costly, polluting, or depleting of natural resources. Centralized processing and enhanced convenience usually reduce waste and save resources while improving product quality. Convenience need not be incompatible with the environment and sustainability, and it saves you time that you might more productively use otherwise. ■

If you have the skills and time, cooking meals from their basic ingredients is the way to go. But don't automatically assume that the alternative is too costly, polluting, or depleting of natural resources.



TECHNOLOGY REVIEW PHOTO CONTEST WINNERS

Photographing the Journey

Scores of photographs depicting various means of moving from one place to another reveal people's ingenuity in devising creative solutions to practical problems. Entrants to Technology Review*'s photo contest this year, with the theme of "The Technology of Getting There," submitted images of such diverse contraptions as a wheeled Mongolian yurt, industrial piping, rappel lines, and a river-crossing system consisting of a raft tethered to a rope stretched across the water.*

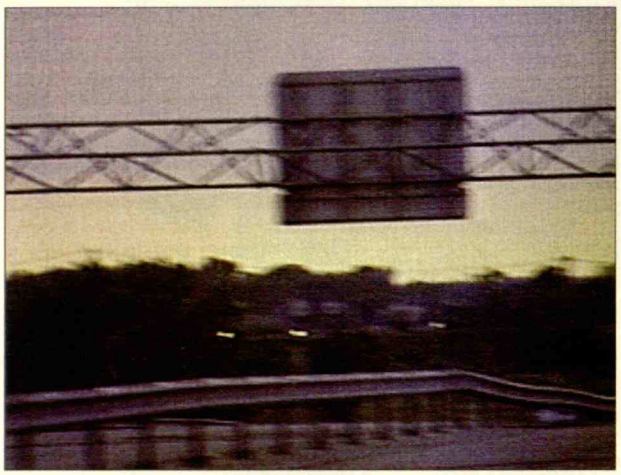
The contest's judges—Nancy L. Cahners, Technology Review *senior designer; John P. Jacob, director of the Photographic Resource Center in Boston; and David L. Ryan,* Boston Globe *staff photographer—chose the winning entries after lively discussions of the photos' creativity and technical and historical merits as well as the emotional responses they evoked. This year, given that a number of submissions had been manipulated by computers or made using imaging processes not based on traditional cameras, the judges even launched into a debate over what constitutes a photograph—a dilemma undoubtedly becoming more common as imaging technologies undergo dramatic changes.*

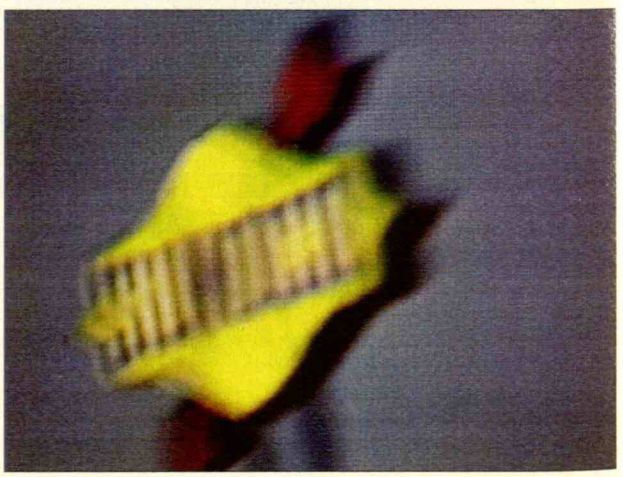
Here, then, are the winners. We thank all who participated.

FIRST

GERSHON PARENT OF SEATTLE WINS FIRST PRIZE FOR A PHOTOGRAPH OF A FATHER GETTING SOMEWHERE FASTER BY ROLLERBLADING WHILE PUSHING A BABY IN A STROLLER. THE JUDGES ADMIRED THE IMAGE'S HUMOR AND WERE IMPRESSED, AS CAHNERS SAID, THAT "ALL THE INGREDIENTS—CONTENT, COMPOSITION, TIMING, AND SENSE OF MOTION—WERE RIGHT." PARENT TOOK THE PHOTOGRAPH WITH AN OLYMPUS IS 1 CAMERA AND KODAK T MAX 400 FILM.

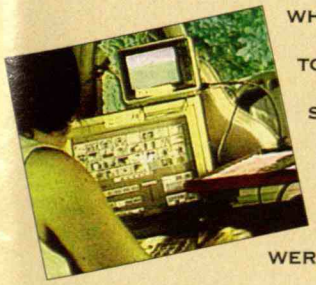
SECOND





THIRD

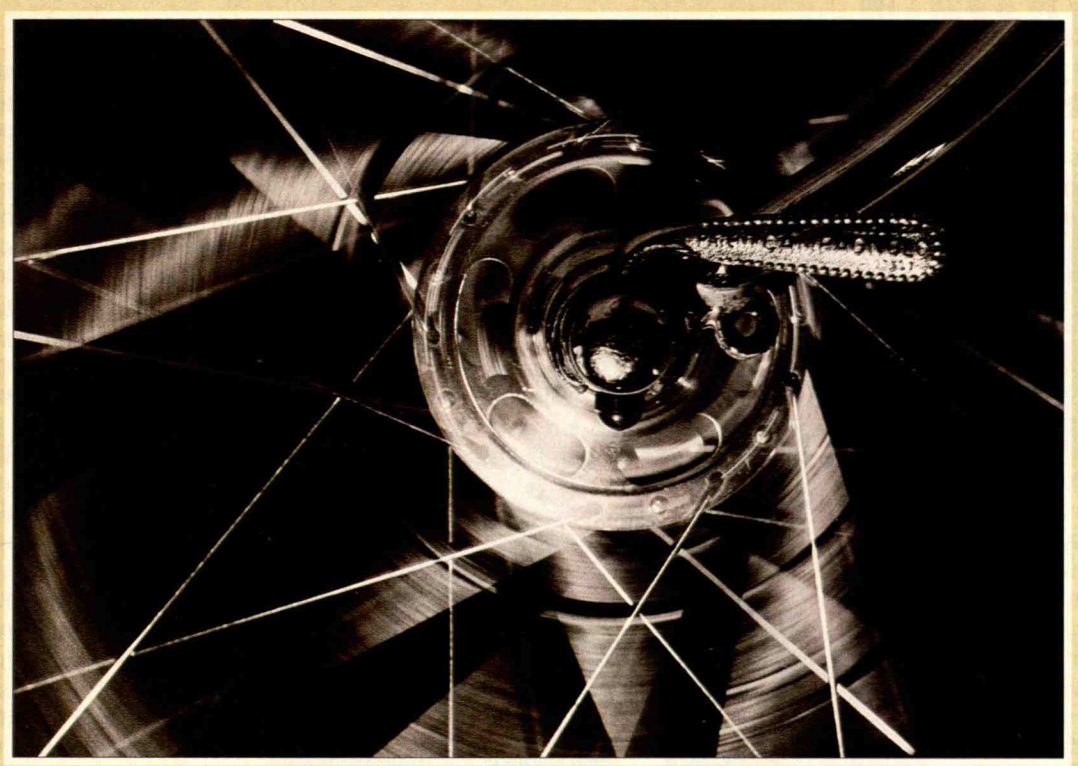
THE JUDGES AWARDED SECOND PRIZE TO AMY WILKINSON HUFNAGEL OF LAFAYETTE, N.Y., FOR A SERIES OF IMPRESSIONISTIC IMAGES SHE PRODUCED WHILE TRAVELING CROSS-COUNTRY IN A VAN LAST SUMMER. HUFNAGEL REMOVED THE BACK SEAT TO MAKE ROOM FOR A VIDEO CAMERA, COMPUTER, CELLULAR PHONE, FAX MACHINE, AND DYE-SUBLIMATION PRINTER, ALL OF WHICH ENABLED HER TO PRODUCE IMAGES THAT SHOWED, AS SHE PUT IT, "GENERATION-X DRIVE-BY HYPER-VISION." THE JUDGES WERE INTRIGUED THAT HUFNAGEL INTERPRETED THE THEME BOTH IN HER IMAGES AND IN HOW SHE MADE THEM.



THIRD PRIZE GOES TO DON BURMEISTER OF NEW YORK CITY FOR HIS PHOTOGRAPH OF TWO RIDERS OF THE IRT SUBWAY SYSTEM. JACOB ADMIRED THE WAY THE PHOTOGRAPHER CAPTURED THE ALIENATION PEOPLE OFTEN EXPERIENCE IN SUBWAYS, WHILE RYAN POINTED OUT THAT BURMEISTER "COULD HAVE BEEN BEATEN UP." THE PHOTOGRAPHER USED A NIKON 8008 CAMERA WITH A 50 MM LENS AND KODAK EES FILM.

HONORABLE MENTION GOES TO ANN SCHAU OF HILTON HEAD ISLAND, S.C., WHO WAS GETTING FROM HERE TO THERE BY BICYCLE WHEN SHE HAPPENED TO SEE A CREATIVE ATTEMPT TO RETURN TWO CANOES TO SHORE. (THE CANOER RETURNED WITHOUT GETTING WET.) SCHAU USED A MINOLTA MAXXUM 700SI CAMERA, A 75-300 MM LENS, AND AGFACOLOR XRS 400 SPEED FILM FOR HER ENTRY.

MENTION

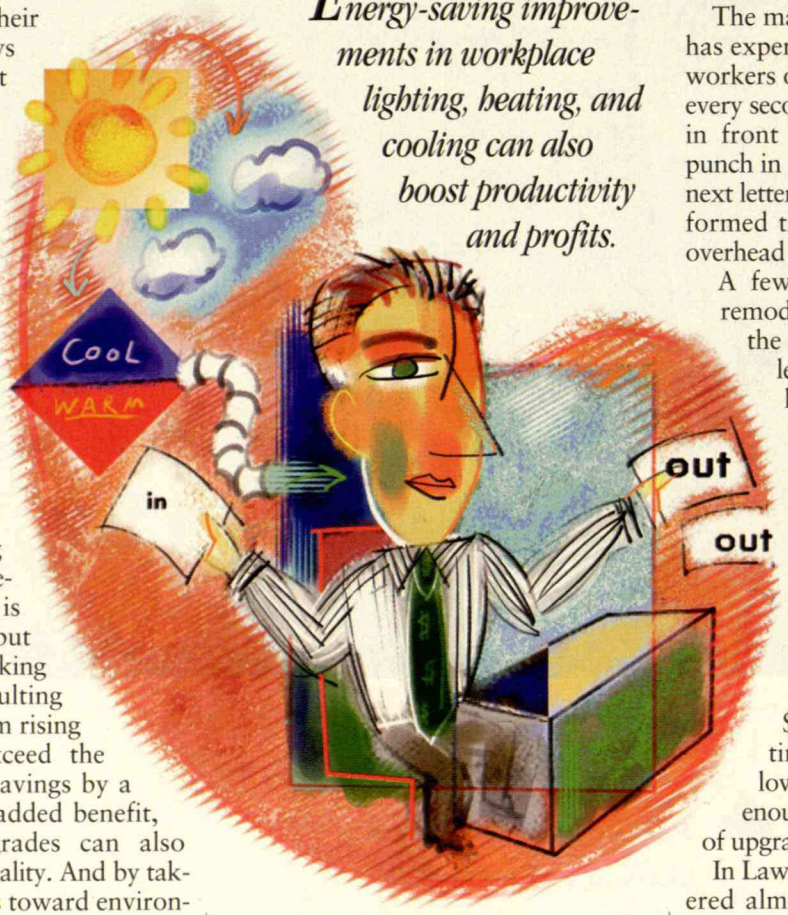


JOHN HERMANNSSON'S PHOTOGRAPH OF A SPINNING BIKE WHEEL ALSO DREW HONORABLE MENTION FROM THE JUDGES. THE "BEAUTIFULLY DONE" IMAGE IS REMINISCENT OF 1920S PHOTOS OF MACHINERY, JACOB SAID. HERMANNSSON, AN ARCHITECT IN REDWOOD CITY, CALIF., TOOK THE SHOT WITH A MAMIYA C220 CAMERA, AN 80 MM LENS, AND ILFORD PAN HP5 PLUS 400 FILM.

JOSEPH J. ROMM

The Benefits of Lean and Clean

Energy-saving improvements in workplace lighting, heating, and cooling can also boost productivity and profits.



MILLIONS of people spend their working days in settings that are too hot, too cold, too noisy, too bright, or too dim. Much has been made in the last decade of how much energy such practices waste. But there is an even more compelling reason to make the workplace more comfortable: higher productivity.

Lean-and-clean design means giving workers the lighting, heating, and cooling they need for their specific jobs; any more is not only wasteful but also creates poor working conditions. The resulting growth in profits from rising productivity can exceed the bonus from energy savings by a factor of 10. As an added benefit, some of these upgrades can also improve indoor air quality. And by taking conspicuous steps toward environmental responsibility, companies can reap a public relations reward.

The first thing a lean and clean company should do is replace old lighting. This one simple step may improve the quality of work in any company, particularly one whose employees are involved in precise detail work. According to a 1991 Harris Survey, 47 percent of office workers report eye strain on the job. The Environmental Protection Agency's Green Lights program is a good source of information not only on lighting technologies that work best for particular applications but also on financing opportunities.

Three examples illustrate the potential benefits. Boeing recently upgraded more than one million square feet of its jet-manufacturing facilities with new, high-quality lighting. Because these lights use as little as one-tenth as much electricity as the ones they replaced, this change paid for itself in two years in energy savings alone. But the upgrade also reduced errors by replacing fuzzy, distracting lighting with fixtures that provided crystal-clear vision and excellent color rendition.

For example, in one Boeing shop, workers use numerous fasteners to attach a jet's interior wall panel to a stiffening member. The old fluorescent lighting provided poor contrast and made it difficult to tell if a fastener had been properly attached. Many errors went unnoticed until the panel was installed in the airplane, where it is far more expensive to fix. The shop now uses metal-halide lamps, which improve the workers' ability to detect imperfections in the shop by 20 percent. One Boeing manager estimates that this early detection of mistakes yields a bigger cost savings than the reduced energy consumption.

The main post office in Reno, Nev., has experienced similar savings. Postal workers operate two sorting machines: every second, the machine drops a letter in front of the operator, who must punch in the correct zip code before the next letter appears. Employees long performed this task under harsh, direct, overhead lighting.

A few years ago, the post office remodeled the room housing one of the two sorter machines, giving it less intense, indirect lighting. A lower ceiling enhanced this lighting—a change that also made the room easier to heat and cool and improved acoustics. Productivity rose 6 percent, and Reno's mail sorters became the most productive and error-free in the western United States. The productivity gain and error reduction save more than $400,000 a year—about eight times the cost reduction from lower energy use, and more than enough to cover the $300,000 cost of upgrading the entire building.

In Lawrence, Kan., Wal-Mart discovered almost by accident the business benefit of good old-fashioned daylight. Extensive use of daylight lowers the cost of electrical lighting and can reduce the need for air-conditioning. But the retail giant discovered a productivity advantage as well. To save money, Wal-Mart put skylights on only half the roof. The company then discovered that the volume of sales per square foot was "significantly higher for those departments located in the daylit half of the store," according to Tom Seay, Wal-Mart's vice-president for real estate, and exceeded that of the same departments in other Wal-Mart stores. This result fits with the findings of many studies and surveys, which have shown that people prefer daylight to artificial illumination.

To further enhance both energy efficiency and productivity, new systems make it possible to tailor the environment of a small workspace to the com-

ILLUSTRATION: SUSAN LEVAN

fort of an individual. No longer need the entire heating and cooling system be driven by a manager or by a few vocal employees who want it hotter or colder than everyone else.

West Bend Mutual Insurance has reaped substantial benefits by incorporating "environmentally responsive workstations," or ERWs, into its new headquarters building in West Bend, Wis. Radiant heaters and vents are built directly into furniture and adjusted by a desktop control panel so that workers can have direct control over the temperature and airflow in their workspace. Workers can also adjust individual task lights to the desired level of brightness. These workstations let individuals create a customized workspace environment that might differ considerably from one preferred by the person at the neighboring desk.

Thanks in part to the ERWs, electrical cost per square foot of the new headquarters is 40 percent lower than in the old building, and worker productivity is 15 percent higher. A number of factors have contributed to this improvement, but researchers from the Rensselaer Polytechnic Institute found, by turning off selected ERWs at random, that the workstations alone boosted productivity by at least 2.8 percent. This gain represents a ten-fold greater cost savings than that from lower electrical use.

The next few years will be an especially opportune time for companies to institute lean-and-clean technologies. One big impetus is the phase-out of chlorofluorocarbon (CFC) coolants, which will force most companies to replace their central air-conditioning systems with versions that can use non-CFC coolants. But a systematic, multistep approach to making the building more energy efficient can turn what might have been a costly change into a chance to increase profits and productivity. A company should first reduce the cooling load through an energy-efficient lighting system (which puts out less waste heat), better insulation, new windows, a more reflective roof, and variable-speed motor controls on ventilation fans. The replacement cooling system can then be half the size of the existing one, dramatically reducing the cost and yielding paybacks for the entire building upgrade of two to five years.

Many lean and clean technologies are the direct result of public investment by the Department of Energy's energy efficiency program. For instance, a $3 million investment in the late 1970s helped two small businesses develop a high-frequency electronic ballast, which efficiently powers fluorescent lamps without the distracting hum and flicker. These ballasts have already saved U.S. businesses $850 million in energy costs, according to the Lawrence Berkeley National Laboratory. The program's investments in new lighting, heating, cooling, motors, and clean industrial technologies offer hard-to-beat returns on taxpayer dollars. A DOE study found that a 10–20 percent decrease in waste by U.S. industry would, by freeing up money for more productive investment, generate 2 million new jobs—not even counting the jobs created by capturing the growing export market for clean technologies.

While some in Congress have seen the energy efficiency program as having only an environmental justification, it has far greater benefits to U.S. economic growth and business competitiveness by lowering costs and increasing productivity. That's a key reason the previous Republican administration steadily increased the program's budget, a trend this administration has continued. Bipartisan support of lean and clean investment is essential if the U.S. economy is to enjoy a continually rising quality of life.■

JOSEPH J. ROMM, special assistant for policy and planning to the deputy secretary of the U.S. Department of Energy, is author of Lean and Clean Management: How to Increase Profits and Productivity by Reducing Pollution *(Kodansha, 1994), and coauthor, with William Browning of Rocky Mountain Institute, of a study on using energy-efficient design to increase productivity.*

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Wither Technology Policy?

THE Republican takeover of Congress threatens to cut short an important shift that had been under way in national technology policy. The Clinton administration has embarked on a diverse effort, sometimes building on programs initiated in the Bush administration, to boost the country's economic performance by directly subsidizing R&D in areas of industrial importance. Such policies are sharply at variance with the Republican ethos of reducing the government's direct intervention in industrial affairs, preferring instead to use tax and trade policies to provide incentives for private investment in R&D. As a result, major battles loom over the shape of technology policy in the next several years.

The national track record with direct R&D subsidies—under both Republican and Democratic administrations—has included both successes and failures. The 1862 Morrill Act, which made the fruits of government-supported R&D available for commercial agricultural use, put in place the most productive farming system in the world. Research conducted by the National Advisory Committee on Aeronautics, which was established in 1915, fueled the U.S. aviation industry's rise to world preeminence. Over the last 25 years, however, direct government support for industrial R&D has often led nowhere, as was the case with the aborted forays into synthetic fuels, supersonic transport, and breeder nuclear reactors.

But the nature of international industrial competition has changed. Joint government-industry efforts in other nations are advancing in sectors that the United States has long dominated. Wide-bodied passenger aircraft produced through the combined efforts of European governments and Airbus Industries, for example, now command some 30 percent of world market share. Japanese companies hold a virtual monopoly on the market for flat-panel displays, an essential component of portable computers and many other products.

The Clinton initiatives to counteract these challenges have included direct government support of R&D in semiconductor manufacturing, the development of a high-performance, low-pollution automobile, and the establishment of a national capability to manufacture flat-panel displays. The administration has rapidly escalated funding for the Department of Commerce's Advanced Technology Program (ATP)—a joint government-industry effort addressing high-risk generic technologies of industrial importance—and for the Department of Defense's Technology Reinvestment Program, which focuses on developing "dual use" technologies that have both military and civilian application.

The Clinton administration has also initiated a network of manufacturing extension centers that foster adoption of new technology in small- and medium-size manufacturing companies. A total of more than $1 billion has been committed to these efforts. The federal laboratory system has also moved, with the encouragement of Congress and the president, to promote economic growth through cooperative research and development agreements with industry. In all these efforts, private-sector funds have matched government grants.

Can this progress be sustained, now that the legislative branch is under the control of the party that takes a dim view of any governmental R&D effort smacking of "industrial policy"? There is no doubt that Clinton's technology programs will feel at least a pinch—and maybe an ax. The Republicans vow to lower federal spending. But with huge entitlement programs and much of the military budget virtually sacrosanct, budget cutters will have to direct their attention to the so-called "discretionary" spending—a category that includes federal support for R&D.

So far, GOP calls for change have not focused on science and technology. And there will probably be bipartisan support for some policies that make the overall economic climate more conducive to R&D, including attempts to lower the budget deficit. The approval of the General Agreement on Tariffs and Trade is a major bipartisan achievement in opening markets and liberalizing trade. But an appendix to the Republican "Contract with America" put forth as an agenda for the first 100 days of this session lists "examples of possible offsets for the 1994 and 1995 budgets"—a potpourri of areas to be considered for spending cuts. R&D-related activities proposed for possible reductions total over $10 billion. Among the candidates for reduction are ATP and the High Performance Computing Initiative, which seeks to promote the development and application of computers and networks.

The federal government has made substantial commitments to advancing the U.S. technology enterprise during the past two years. Innovative programs have gained strong momentum. It would be unfortunate if this momentum were arrested before the results of government investments are known. ■

ROBERT M. WHITE is president of the National Academy of Engineering.

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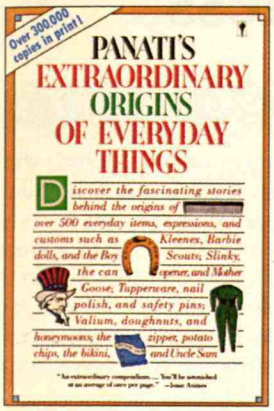

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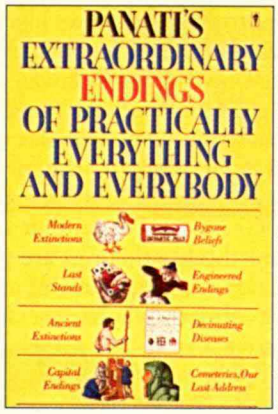

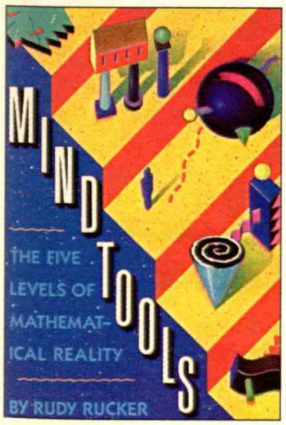

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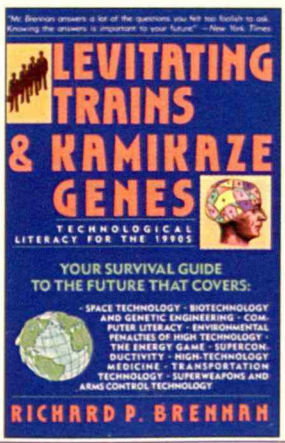

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Sheriffs of Scientific Correctness

THE disruptive culture wars that have swept through universities and museums recently seem to have found a new target: scholarly portrayals of science. Summoning up vituperative zeal formerly reserved for Mapplethorpe photographs and "politically correct" speech, conservative critics charge that the musings of humanists and social scientists involved in science studies now threaten not only the practice of science but also the very future of Western civilization.

At issue is research by sociologists, anthropologists, historians, and other academics during the past two decades whose basic aim is to give science the same close, critical scrutiny that science applies to everything else. The best new work in science studies neither celebrates nor mocks the work of science but rather seeks to show how thoroughly scientific knowledge is intertwined with the complex fabric of social life. For example, a growing number of writers observe that even the knowledge claims of physics and biology are shot through with subjective judgments about the abilities of males and females as well as different ethnic groups. Findings of this kind stand in sharp contrast to the conventional belief that science is and ought to be uniquely rational, objective, and politically pristine.

Until recently the heresies brewing in science studies were politely ignored by those who held the more traditional view. But a new book, *Higher Superstition*, by biologist Paul Gross and mathematician Norman Levitt, finally throws down the gauntlet.

Surveying the literature, Gross and Levitt find hideous "distortions and exaggerations about science" as well as fervent passions of "antiscientism." The source of these aberrations is an amorphous entity they label "the academic left," a collection of postmodernists, social constructivists, feminists, and multiculturalists who have risen to prominence in universities. Such people "revile [science] as an ideological prop of the present order, which many of them despise and hope to abolish." Among those most reprehensible, in Gross and Levitt's view, are those who would alter scientific research to match the agendas of radical environmentalism, AIDS activism, and Afrocentric politics.

Gross and Levitt note that much of the new research has not paid close attention to the content of natural sciences. They have a point there. But what really infuriates these authors are suggestions that the scientific community needs to reform itself. Especially repellent to them are views like those of Sandra Harding, a feminist philosopher at the University of Delaware, who stresses the need to balance the dominance of white middle-class males with perspectives of women, the poor, and the world's diverse ethnic populations.

Gross and Levitt fear that such unorthodox theories are poisoning the minds of college students and undermining formerly wholesome ideas about science in both the university and mass media. To remedy this alleged menace, they propose to grant to natural scientists veto power over the hiring, teaching, and research of any colleagues in the humanities and social sciences who dare say anything about the inner workings or deeper motives of science. Gross and Levitt say they "are not calling for a purge of the institutions of higher learning in this country." In fact, suppressing dissent is exactly what they have in mind; the freedom of inquiry would now be guarded by self-appointed sheriffs of scientific correctness.

Ironically, defending science in this way reflects a flagrantly antiscientific prejudice. It presumes that the production of scientific knowledge can be judged from only one standpoint—that of a priesthood of insiders. But shouldn't scientists welcome the attempts to reexamine their comfortable self-conceptions and to imagine their enterprise in a fresh light? In fact, humanists and social scientists are revealing dimensions that natural scientists themselves have been unwilling or unable to explore.

So far, this debate is being conducted largely behind the walls of academe, in decisions about tenure, promotions, and course content. But during the past year, the issue has moved into a more public venue, as battles have broken out over the content of science and technology exhibits at the Smithsonian Institution. One exhibit, "Science in American Life," was the focus of efforts by the American Chemical Society to remove displays that expressed concern for environmental damage and social justice. For the industry's partisans, only nicely sanitized versions of scientific progress are suited for public consumption.

As political arm-twisting of this kind gains momentum, museum curators and university teachers will face strong pressures to conform. Those who would suppress the disturbing ideas of science studies should reexamine their commitment to the kinds of open, critical inquiry that both science and democracy require.■

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PHOTO: L. BARRY HETHERINGTON

Reviews

BOOKS

THE SHIFTING TAX BURDEN

America: Who Really Pays the Taxes?
by Donald L. Barlett and James B. Steele
Simon & Schuster, $9.95 in paperback

BY JONATHAN SCHLEFER

PRESIDENT Reagan as well as congressional leaders on both sides of the aisle billed the Tax Reform Act of 1986 as creating a fairer system. "All Americans win because the tax code is simplified and loopholes are closed," said Rep. William B. Richardson (D-N.M.). By shifting $120 billion of the federal income tax liability from individual taxpayers to corporations, "this bill restores a balance in the tax code that has been upset over the years," Sen. William S. Cohen (R-Maine) maintained.

Somehow it did not work out that way. Before the 1986 reform, individuals had been paying 75 percent of federal income taxes, corporations 25 percent. Seven years later, individuals' payments had risen to 82 percent of the total while corporate payments had fallen to 18 percent. Corporations had paid $226 billion less in taxes than the White House had forecast.

According to Donald L. Barlett and James B. Steele, authors of *America: Who Really Pays the Taxes?*, such discrepancies are not wholly the result of simple ineptitude. Their book is an account of widespread venality. The authors claim that from the 1950s to the present, moneyed interests—large corporations and rich individuals—have bought tax breaks from politicians at the expense of the middle class. Although I would object to a point here or there—Barlett and Steele often compare individuals' income with corporate receipts, for example, when the closer analogy is to corporate profits—the broad sweep of evidence amply corroborates their claim.

The authors point out that if corporations paid at the same rate today as in the 1950s, they would nearly eliminate the federal budget deficit. Among individuals, the burden has shifted from the wealthy to middle America; for instance, from 1971 to 1991 the combined Social Security and income tax bills of median-income families rose 329 percent, while those of families with incomes of over $1 million fell 34 percent. The authors' figures are broadly consistent with sources such as the Census Bureau's Statistical Abstract of the United States.

The book does leave some questions unanswered, however. For one, are high taxes on corporations and the rich, even if justified by fairness, detrimental to the economy? As the authors note, Andrew Mellon, treasury secretary in the 1920s, argued that reducing taxes on the wealthy "increases the amount of capital which is put into productive enterprises, stimulates business, and makes more certain that there will be more $5,000 jobs to go around." This was a favorite argument of the Reagan administration. Liberals such as Sen. Edward M. Kennedy (D-Mass.) used it to push for tax breaks for local industries. And the very core of standard economic theory implies that attempts to heavily tax capital harm the economy. Even workers often believe that high taxes on profits can prompt employers to curtail production and cut jobs.

These are at best half-truths. Tax cuts benefiting tangible investment in business enterprises—not speculation on money markets or paintings by Van Gogh—may at times help an economy. But I would argue that a reasonably equitable distribution of income, to which a progressive tax structure contributes, is surely at the core of what we mean by economic prosperity. Moreover, such equity is important even to the narrower economic measure of GNP growth. One way of looking at the matter is as follows: No matter what inducements are offered for investment, it cannot continue like a perpetual chain letter but must ultimately produce goods for consumers. As John Maynard Keynes wrote in *The General Theory*, "Consumption—to repeat the obvious—is the sole end and object of economic activity." And proportionally to their income, the truly wealthy are not big consumers: notwithstanding the conspicuous consumption of the 1980s, they largely save and invest. Those in the middle class are the real consumers. The extraordinary economic prosperity of the 1950s and 1960s depended on investment but also on rising wages and an equitable income distribution after taxes, which gave the middle class the means to purchase the output of investment.

Elements of Change

This argument raises another question Barlett and Steele fail to address: If well-funded special interests are so effective at getting breaks from greedy politicians, how can we ever reform the system? Indeed, why was it that in the 1950s taxes were remarkably progressive? The top tax rate on incomes over $400,000 was then 91 percent. One cannot just say that somehow business and politics have become more venal down through the ages. Quite the contrary, there is every evidence that nineteenth-century politicians, who were readily bought by the

ILLUSTRATIONS: JON McINTOSH

robber barons, had even fewer scruples than their counterparts in the 1990s.

There is more to politics than mere greed. One reason the wealthy started paying taxes was war. World War I demanded unusual sacrifices—the lives of soldiers, the money of the rich. Income taxes rose during World War II also, which saw "the largest tax increase in American history," according to Barlett and Steele.

But war alone did not bring changes in the tax code. The government began heavily taxing the rich years before World War II and kept it up years afterward. It was in 1936 that the Roosevelt administration raised the top tax bracket to 79 percent, up from 25 percent in the 1920s. In the 1950s, the Republican Eisenhower treasury fought lowering taxes on the wealthy and maintained New Deal tax structures.

Something strange was going on. I have a hunch that social unrest, along with acceptance of its legitimacy among at least part of the elite, played a role. In the last paragraph of their book, Barlett and Steele raise a "disturbing question" posed by several individuals they interviewed, including a "white man in a three-piece business suit in Philadelphia." "Do you really believe these problems can be solved without people taking to the streets?" he asked. The answer, in a word, is no. It took some goading to pass the Social Security Act and the Wagner Act strengthening unions and thus the economic status of middle Americans. FDR was progressive but also knew to look to the coalition that elected him. And citizens had taken to the streets—just before the election, veterans had camped on Washington, demanding pensions; auto workers endured bitter strikes and faced violence to secure union recognition. Such demands and elite concerns about them surely helped prompt the Roosevelt administration to redress economic inequities, in part through progressive taxes, and the memory of that era may have made the Eisenhower administration reluctant to tamper with any of the mechanisms that had been put in place.

I suspect another factor was important as well: the United States from the 1930s through the 1950s was virtually a closed economy. It was not just that the Smoot-Hawley tariffs had drastically reduced trade. It was also that U.S. investors were wary: in the collapse of the international financial system during the Depression, they had lost a lot of money.

One of the implications of this closed economy was that if the federal government raised taxes, more or less all capitalists had to contribute their fair share. They could not move production to "Singapore, Ireland, or any other tax haven that is begging us to come," as Irwin Lerner, chairman of Hoffman-LaRoche, recently threatened to do if taxes were raised on one of his Puerto Rican plants. Moreover, if the government raised taxes on U.S. firms to fund social security or war, those firms could reasonably expect increased demand for their products. Today, domestic producers may bear the tax burden while foreign competitors reap the benefit of the resulting demand. Each nation faces a similar problem, and taxes on corporations and the wealthy have fallen not just in the United States but broadly across the developed world.

One solution might be to close economic borders again. This is not inconceivable: there are rumblings of political forces on both left and right in the United States and Europe to do so. Moreover, the nineteenth century was a world like ours—international flows of goods and investment may even have been relatively larger—and it came to an end. However, there is no evidence that the scope of the international economy could be restricted in any controlled or benign way: last time it took World War I and the Depression.

Despite the enormous obstacles to achieving it, a more plausible alternative might be to extend political sovereignty—establish a measure of global authority to enforce basic social protection, including minimal labor rights and environmental standards. International taxes would also be a good idea—for example, a small percentage of every financial transaction or a tiny fee on every bit of computer data transmitted across borders. There already are global institutions that might do this, among them the World Trade Organization created in the latest round of GATT (the General Agreement on Tariffs and Trade). The WTO's stillborn predecessor, the International Trade Organization, which the U.S. Congress rejected in the late 1940s, included a chapter on labor rights. Such international governance might begin to restore on a broader scale something of the closed economies that, from the 1930s through the 1950s, allowed national states to maintain progressive taxes, temper capitalism, and promote social welfare. ■

JONATHAN SCHLEFER is a doctoral candidate in political science at MIT. A former editor of Technology Review, *he has written for such publications as the* Atlantic *and the* New York Times.

BOOKS

LOVE OF LIFE

The Biophilia Hypothesis
edited by Stephen R. Kellert and Edward O. Wilson
Island Press, $27.50

BY CHRISTINE MLOT

You won't find the word biophilia in the dictionary. Not yet, at least. But you will hear conservationists and biologists use it to describe why they do what they do: they are drawn to other living things out of a deep-seated emotional affinity for life. The word began to gain currency after E. O. Wilson of Harvard University used it as the title of his 1984 book about conservation. Our emotions for living things are innate, he posited, the result of having spent the bulk of our evolutionary history as hunter-gatherers in close contact with other species. Whatever genetic con-

figuration enabled our ancestors to eke out a living persists in our urban lives today and expresses itself in our predilection for pets and houseplants, and in any responsiveness we might manifest to the loss of biological diversity around us.

Ten years later, in *The Biophilia Hypothesis*, Wilson and 19 other contributors lay out the case for a biological basis to what Thoreau described as our fascination with even the "simplest and most lumpish fungus." No one has found a specific gene for biophilia, or even set out to find one. Rather, the thinking goes, innate "learning rules" regarding living things give rise to an array of cultural behaviors—just as innate rules regarding grammar generate an array of languages.

Our link with our hunter-gatherer forebears is not difficult to establish. After all, we still look like these early humans, the all-important use of language arose during this time, and nutritionists even tell us that we run best on a high-fiber Stone Age diet. It only follows that our brains could retain the capacities and affinities for interacting with other animals and plants, particularly those that existed during the same period.

The savanna, birthplace of bipedalism, is supposed to be our habitat of choice, for example. Across cultures, people express preference for pictures of grasslands dotted with trees—the same landscaping we put in our parks—and almost any natural scenery rates over urban scenery. Sources of water score points, too. Whatever relief these oases must have provided our ancestors lingers today. Lower blood pressures, calmer dental patients, and quicker postoperative recoveries have all been recorded in controlled studies of patients given a room, or even a poster, with a green view.

Reigning Fears

Wildness is key, many of the writers maintain. A hunter-gatherer's terrain holds as much to avoid as to pursue, and biophobia is as much a part of our innate operating system as biophilia. It is also better documented. According to both folklore and psychological studies, snakes

are the reigning object of Western fears, notwithstanding the far greater threats of guns and cars. The fear response to snakes is not only quick to appear but resists the "extinction" that usually happens with responses to repeated stimuli. An innate biophobia may also be at play in our treatment of tropical forests, Roger S. Ulrich, an environmental psychologist at Texas A&M University, suggests—despite their biological importance, these predator-filled places haven't inspired the solicitude that, say, whales have.

Other contributors are less interested in wildness itself than in the overriding impact that learning and culture can have on it. Jared Diamond, a field biologist and physiologist at the University of California Medical School, observes that forest-dwelling New Guineans (as well as his young sons) exhibit little fear of snakes. They simply make a distinction between poisonous and palatable species, the way a knowledgeable mycologist fearlessly avoids deadly mushrooms. In fact, the Western aversion to snakes may be recent, not ancient, in origin. As we became more removed from the wild and stopped eating fare like snake meat, we may have lost the specialized knowledge it takes to be a discriminating snake consumer and developed a blanket fear of the creatures.

Still other authors are drawn to questions that seem to call the biophilia hypothesis into question. For instance, if, as the theory maintains, we have a special affinity for animals we coevolved with, something else must be behind the craze for dinosaurs. Madhav Gadgil, a biologist at the Indian Institute of Science, suggests it is complexity that attracts us, not just biology. Hence dinosaurs can hold our interest as easily as cats can—and, for that matter, so can machines. Gadgil's theory could explain why his son, at 14, was as absorbed by his computer as he was by birds at an earlier age, and why for some people virtual environments have it over real ones. In these cases, technophilia has replaced the focus on a now-remote wilderness, an adaptation of a sort.

Don't look to this book for lyrical nature writing, with the exception of a couple of essays. The editors and authors have set out to establish the biophilia hypothesis as an area for scientific inquiry, and the result, especially in some of the earlier chapters, are pages of statements like "The possession of [outdoor] skills and associated states of mental and physical well-being have been empirically described for a variety of contemporary outdoor activities with a strong emphasis on the naturalistic experience." You'd be better informed about biophilia by taking a hike.

Consult *The Biophilia Hypothesis* as a detailed sourcebook on the evidence for a genetic basis to human behaviors and emotions. But turn to writers like Thoreau to evoke the essence of the feeling: "The simplest and most lumpish fungus has a peculiar interest to us, compared with a mere mass of earth, because it is so obviously organic and related to ourselves, however mute," he writes in the October 10, 1858, entry to his *Journal*. "It is the expression of an idea; growth according to a law; matter not dormant, not raw, but inspired, appropriated by spirit. . . . the humblest fungus betrays a life akin to my own. It is a successful poem in its kind." ■

CHRISTINE MLOT, a science writer and editor who is based in Wisconsin, held a Knight Science Journalism Fellowship at MIT in 1993-94.

BOOKS

GOING FOR THE GREEN

Green Gold: Japan, Germany, and the United States, and the Race for Environmental Technology
by Curtis Moore and Alan Miller
Beacon Press, $25

BY JACOB PARK

FOR years, the goals of economic development and environmental protection seemed irreconcilably opposed. Countries and companies argued that strong environmental regulations would give unfair trade advantages to economic competitors. However, after nearly a decade of global environmental initiatives culminating in the 1992 Earth Summit, many observers have concluded that environmental regulations actually promote innovation and trade. Tantalizing business opportunities are seen to lie with "green" consumer products ranging from detergents and cosmetics to minimally polluting energy sources like photovoltaic and fuel cells.

In fact, the global market for such products amounts to $200 billion today and is expected to grow to $600 billion by the year 2000. In *Green Gold*, Curtis Moore, a lawyer based in Washington, D.C., and Alan Miller, director of the Center for Global Change at the University of Maryland, document how industrialized countries are staking their economic future on that market.

Pointing to Germany's "longstanding and remarkably successful policy of building competitiveness through technological innovation," Moore and Miller argue that perhaps more than any other country, it has shown how stringent environmental regulations can lead to innovation, how innovation can enhance international competitiveness, and, finally, how the results can enhance the domestic economy and create jobs. Consider, for example, the German environmental regulations for power plants, steel mills, and other large polluters. Such facilities are subject to constant reviews to ensure that the newest and most advanced environmental technologies are in place. Not surprisingly, German companies, having grown familiar with these technologies, are now constructing innovative power plants in Denmark, the Netherlands, Turkey, and other countries. Germany has also developed high-tech rail systems that are now competing for the multibillion-dollar Amtrak contract to serve the Boston-Washington, D.C., rail corridor. Indeed, the number of German companies in the environmental industry has risen from 1,000 to 4,000 since 1980.

Japan is another key player in the environmental marketplace, thanks in large part to a strong policy emphasis on cooperation between government and industry in developing technologies. The country has spent nearly $60 billion on environmental technologies in the last 20 years, and by 1989 it had installed three times as many systems for cleaning flue gas as the rest of the industrialized world. As a result, Japan has done more than its fair share to reduce acid rain—it emits less sulfur dioxide and nitrogen oxide per person than any other industrialized nation, roughly 90 percent less than the United States. The processes and products that have enabled the Japanese to achieve this feat are eminently marketable.

By contrast, U.S. policies aimed at tapping the global environmental market seem to be perpetually stuck in neutral. For example, industries here have avoided installing pollution-control equipment in favor of simply building taller smokestacks. And although the U.S. government spent several hundred million dollars to develop fuel cells for the space program, funding dried up in the early 1980s—at which point Japanese firms acquired the rights to the technology. The loss of U.S. dominance is clear in the power plant under construction near Doswell, Va. The plant's owner is Mitsubishi, while the manufacturer of the gas turbines is Siemens, a German company, and the manufacturer of the steam turbines is Asea Brown Boveri, a Swedish-German-Swiss conglomerate.

Euphoric Assumptions

Moore and Miller believe that the blame for this sad state of affairs lies mainly with the large domestic energy industry in the United States. Since many state and local governments derive sizable fractions of their tax and other income from energy and energy-related industries, the political constituency favoring continued reliance on inexpensive energy sources like coal, oil, and natural gas is powerful, and that constituency, which includes manufacturers of cars, refrigerators, and other consumer goods, also impedes development of energy projects with longer payback periods such as solar, wind, and conservation. Moore and Miller find fault with the funding priorities of former presidents Reagan and Bush as well. During these administrations, the military budget doubled while federal spending for conservation, solar energy, and other non-oil programs dropped by two-thirds.

But although such observations are insightful, one has to question some of *Green Gold*'s rather euphoric green-is-profitable assumptions. First of all, while stringent environmental standards may

yield positive results for the economy as a whole, some individual companies and industries will nevertheless incur significant costs. For instance, the recently authorized Clean Air Act is expected to cost U.S. petroleum refiners $37 billion–over $6 billion more than the book value of the entire industry.

Second, Moore and Miller focus mainly on advanced industrialized countries, so that it is unclear how much of what they say applies to newly industrialized countries like South Korea or large developing countries like China. And China, after all, boasts 22 percent of the world's population and perhaps the third largest economy. Unless such countries are integrated into the global market for environmental products and services, green gold may prove as illusory as fool's gold.

Finally, the book's major premise is somewhat flawed. The example of Germany and Japan notwithstanding, any link between environmental regulations and international competitiveness is much more tenuous and inconclusive than Moore and Miller acknowledge. Robert Stavins of Harvard's Kennedy School of Government recently reviewed evidence from more than 100 studies on the subject and found little or statistically insignificant connection between environmental regulations and overall trade flows, and even less connection between environmental regulations and technological innovation. Harvard Business School's Michael Porter, who is generously quoted in *Green Gold*, has admitted in *Science* that the data on trade in environmental products and processes are not "fine-grained" enough to permit firm conclusions on such matters. More policy research and high-quality data may indeed show a positive relationship between environmental regulations and international competitiveness. But the fact remains that the existing evidence is simply not overwhelming.■

JACOB PARK is a United Nations University program associate based in Tokyo who specializes in global environmental issues.

Classifieds

Phenomena

By David Brittan

Going for Bronze The news that Boston University School of Medicine has set up a tanning salon for guinea pigs must mean one of two things: (A) guinea pigs everywhere will soon enjoy the rich, golden tans long denied them by a society that is indifferent to the beauty needs of rodents; or (B) there's something in it for humans. If you guessed (B), you win a free tube of sunless tanning lotion, the hoped-for end product of research being conducted by Barbara A. Gilchrest, chair of the school's department of dermatology. So-called instant tanning cremes have been around for years, but they simply dye the skin, and not always convincingly. Gilchrest and two colleagues, molecular biologist Mark S. Eller and dermatologist Mina Yaar, have actually managed to coax pigment cells to work overtime. The researchers smear the shaven skin of guinea pigs with a preparation containing fragments of DNA. The result? A healthy-looking tan every time, with none of the dangers of baking in the sun. Gilchrest says the genetic material appears to touch off an "SOS response" that may occur naturally in pigment-producing cells under strong sunlight. When the sun's UV rays strike skin cells, they often alter the DNA within the cells. "Repair enzymes" are thought then to rush into action, stripping out and replacing damaged sections of DNA. Apparently in response to this flurry of DNA fragments, the skin's pigment cells—the melanocytes, which make up 2 percent of the skin's outer layer—start to pump out UV-blocking melanin. The Boston University DNA preparation contains the same type of genetic material that gets displaced after a UV attack. So in essence, says Gilchrest, the preparation fools the melanocytes into stepping up their melanin production. Besides acting as a sunblock, melanin is prized by white Americans for its ability to confer a patina of youth and vitality, with perhaps an intimation of frequent visits to Cancún. So anything that produces a tan without unpleasant side effects such as skin cancer is bound to find a ready market. "If this proves to be safe and effective on human skin, we are certainly interested in seeing it developed into a product that people could use," says Gilchrest without even a hint of recognition that she may be sitting on the biggest cosmetic gold mine since the tummy tuck. In the meantime, enquiring minds want to know how the first customers are doing. Do the tanned guinea pigs seem younger? More confident? "Just darker," says Gilchrest.

Crocodile Smiles Some of the toughest hides in evolutionary history belong to the crocodilians—crocodiles, alligators, and similar reptiles—but these animals are thin-skinned when it comes to climate change. Many species of croc disappeared in the global cooling that created the first Antarctic ice sheets 35 million years ago. The same thing happened again 2 million years ago, when the Arctic glaciers formed. So how is it that crocodilians survived unscathed 65 million years ago when a major cooling is supposed to have done in the dinosaurs? That's what Paul Markwick wants to know. Markwick, a graduate student in geophysical sciences at the University of Chicago, has compiled an extensive database of fossil records from around the world. The database shows that between 80 and 35 million years ago, "there's this constant coming and going of different types of crocs, but overall the number of species is increasing." No mass exodus at the 65 million-year mark. Turtles, amphibians, and most mammals also appear to have done fine, he says, as did warm-weather plant such as palms. Markwick doesn't dispute the widely held view that a huge object such as an asteroid precipitated the dinos' decline *(see "Comet Busters" on page 22)*. But he doubts that the creatures perished because of a severe global winter that is commonly assumed to have followed the collision. Because the temperature-sensitive crocs were spared, he says, "any cooling that took place can't have been that drastic." Here, then, is the most plausible explanation Markwick can muster for the extinction of the dinosaurs: "There is an impact that puts dust in the air, blocking sunlight for a month or so and killing off a lot of plants. Most of the cold-blooded animals, including crocs, can survive; they simply shut down. But there's a lot of evidence that dinosaurs were warm-blooded: their tracks suggest they were active, for example, and they have many blood vessels going through the bone, typical of warm-blooded animals. Now, if you're warm-blooded and you're large, you have to eat all the time. But these large warm-blooded animals are suddenly without food." The severe shortage of edible plants would have starved carnivorous dinosaurs as well as herbivores, Markwick says, by causing a shortage of live prey.

This Bud's Forever Another perennial mystery is what makes flowers fade. Until recently, everything we knew about flower senescence was summed up by the poet Robert Herrick in the 1600s: "Gather ye rosebuds while ye may,/ Old Time is still a-flying,/ And this same flower that smiles today/ Tomorrow will be dying." But William R. Woodson, a professor of horticulture at Purdue University, believes he can now explain why the life of a flower is so brief. The petals don't just die of old age, he says; the plant kills them off once they have attracted a bird or insect to pollinate the flower, or if the plant is injured. "Petals are very wasteful," says Woodson. "They require a lot of energy to maintain, yet because they usually don't contain chlorophyll, they're not able to produce energy or food." When a plant is pollinated or cut, Woodson says, its ovary emits ethylene gas, a hormone that wafts from one cell to another, spurring each cell to manufacture more ethylene. When the gas reaches the petals, it switches on a gene that tells them the show is over. A fuller understanding of why flowers die after they are cut will lead to better techniques for prolonging their blooms, says Woodson. The U.S. floral industry often coats flowers with silver thiosulphate. This material, which blocks ethylene receptors in the plant, makes cut carnations last up to three weeks but is toxic and has been outlawed in Europe. Woodson says several biotech companies are instead developing genetically engineered plants that produce no ethylene and hence require no chemical sprays to stay alive. The downside of this artificial longevity, of course, is that it will leave poets grasping for new metaphors to express a life that is short and sweet.

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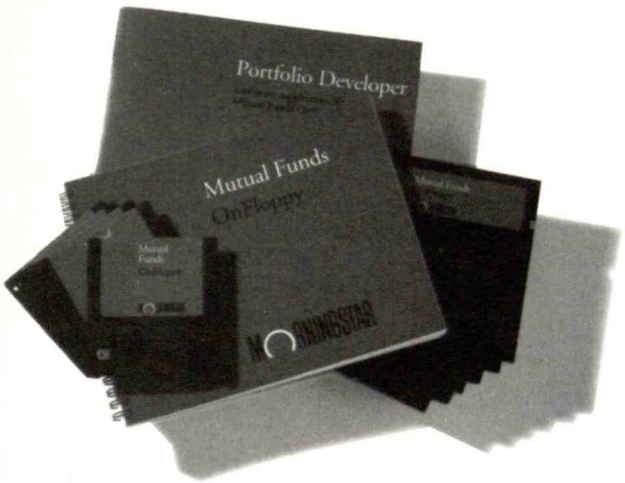

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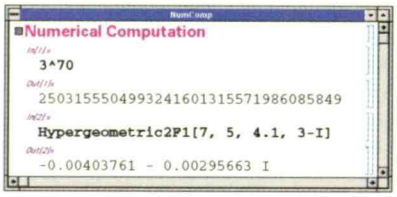

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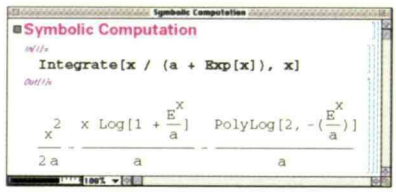

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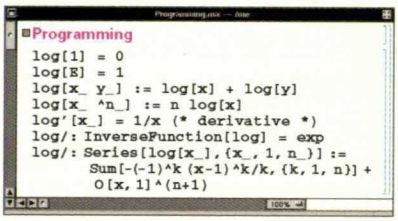

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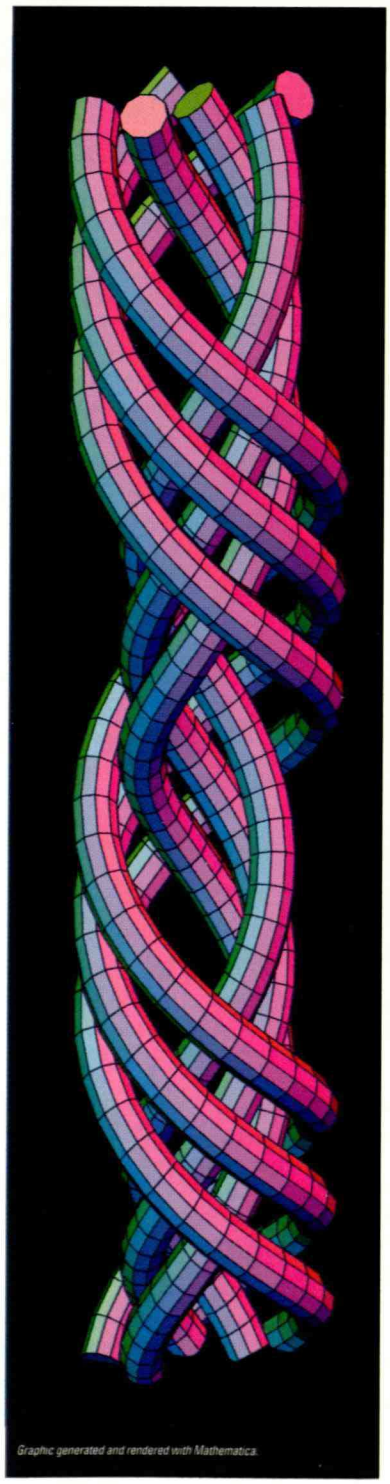

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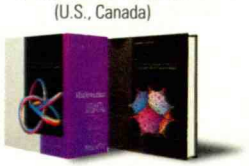

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